TRANSACTIONS

AND

PROCEEDINGS

OF THE

NEW ZEALAND INSTITUTE,

1869.

VOL. II.

EDITED AND PUBLISHED UNDER THE AUTHORITY OF THE BOARD OF GOVERNORS OF THE INSTITUTE,
BY
JAMES HECTOR, M.D., F.R.S.

ISSUED APRIL, 1870.

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PREFACE.

THE first volume of the "Transactions" contained several Communications and Essays that had accumulated from previous years, and it was therefore anticipated in the Preface that the succeeding volumes would not equal it in size. The present issue, however, has not fallen off in this respect, as it contains almost an equal number of pages, which are of larger size; while the number of original Articles has increased from twenty-three to sixty-three, contributed by thirty-two different authors.

The arrangement of the work has been improved by dividing it into Sections, according to the subjects treated of.

Part I. contains the original communications of the various Societies, during the Session of 1869, which have been selected for publication by the Councils of the Societies, and approved by the Board of Governors of the Institute.

These Articles have been classified, for convenience of reference, under the following Sections: I. Natural History,—II. Botany,—III. Chemistry,—IV. Geology,—V. Miscellaneous.

There are three exceptions to this arrangement, owing to the papers not having been received in time for insertion in their proper places:—a Zoological paper by Dr. Haast, "On the Ziphid Whale," and one on a Botanical subject by Mr. Buchanan, appearing among the Miscellaneous Articles; and at page 385, near the end of the volume, an Ornithological paper, by Mr. Buller, has been inserted.

Part II. contains Lectures on Scientific subjects, delivered during the year, in addition to one, by Mr. Fitzgerald, reserved from last year.

Part III. consists of the Minutes of the Proceedings of Meetings of the various Incorporated Societies, which have been condensed from Reports furnished by the Secretaries. Among these Reports will be found abstracts of papers that have not been printed at length, and the Annual Addresses of the Presidents of the Societies.

In the Appendix will be found an abstract of the Meteorological Returns for the year.

The number of members of affiliated Societies, who are entitled to receive copies of this volume, gratis, according to the lists published in the

Appendix, has increased from 255 in 1868, to 342 in last year. The Governors also distribute, as presentations or in exchange, about fifty copies in addition, to various Learned Bodies and Public Libraries.

Although the supply of algebraic type, obtained for the purpose, is still imperfect, the two papers by Captain Hutton, reserved from last year, have been printed in this volume; the deficiencies being supplied by a few letters and signs not generally used in mathematical formulæ, for which the reader's indulgence is requested.

Amongst the papers reserved are several relating to purely medical subjects, chiefly communicated to the Medical Section of the Auckland Institute. As these papers do not contain matter of general interest, the Board considered it advisable to hold them over for future publication, in a separate form, for the professional reader.

Whenever it was found possible, without delaying the progress of the work through the press, proof sheets were submitted to the authors for revision, but in the majority of cases this was found to be impracticable; in which case the final revision, as well as the preparation of the papers for the press, was performed by the Editor. In one instance, the author, Mr. Potts, came from Canterbury to revise the proof sheets of his paper on "Birds," for which attention the Editor desires to express his thanks.

Although every care has been taken to avoid typographical errors, it is necessary to call the attention of authors, and the Secretaries of Societies, to the desirability of forwarding the manuscripts in a more legible form; as, in several instances, the papers had to be re-copied before they were placed in the hands of the printer, thereby greatly increasing the chance of misinterpreting the author's meaning.

Several small errors have been observed since the work has passed through the press, but only those that seriously affect the author's meaning have been placed in an errata slip.

The Illustrations to the present volume have all been drawn on prepared paper, by Mr. Buchanan, and transferred to stone at the Government Lithographic Press,—the Hon. the Colonial Secretary having allowed the Board to make an arrangement with the Government Printer, for the purpose of securing for the work the superior appliances and skill available in the Government Printing Office.

The Editor has again to acknowledge the great assistance which he has received from Mr. R. L. Holmes, who, at considerable personal inconvenience, remained in Wellington to superintend the passing of the work through the press.

The thanks of the Board are also due to Mr. J. Buchanan, who has devoted a large portion of his leisure time to the illustrations of the work.

ERRATA.

Page 49, in Foot-note, for "170,000" read "189,000."
101, line 23, for "sepals, 4-valvate" read "sepals 4, valvate."
107, ,, 39, change parenthesis from before "*Eleogeton,*" to commencement of line.
145, ,, 31, for "*unitica*" read "*mutica.*"
164, in Foot-note, for "scientific" read "specific."
165, line 7, for "extinct" read "recent."
167, ,, 21, for "Turritella" read "Tornatella."
222, 48, for "our" read "one."
285, 30, for "instructive" read "instinctive."
289, , 29, for "quarrel" read "general."
371, 53, after "rocks," for full-stop insert a comma.
388, 50, for "white-crested" read "white-breasted."

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NEW ZEALAND INSTITUTE,

ESTABLISHED UNDER AN ACT OF THE GENERAL ASSEMBLY OF NEW ZEALAND, ENTITLED "THE NEW ZEALAND INSTITUTE ACT, 1867."

1869.

BOARD OF GOVERNORS.

EX OFFICIO.

HIS EXCELLENCY THE GOVERNOR.

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HIS HONOR THE SUPERINTENDENT OF WELLINGTON.

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1869.

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1870.

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HIS HONOR MR. JUSTICE WARD.

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ABSTRACTS OF RULES AND STATUTES,

NEW ZEALAND INSTITUTE,

GAZETTED IN THE "NEW ZEALAND GAZETTE," MARCH 9, 1868.

SECTION I.

Incorporation of Societies.

1. No Society shall be incorporated with the Institute under the provisions of "The New Zealand Institute Act, 1867," unless such Society shall consist of not less than twenty-five members, subscribing in the aggregate a sum of not less than fifty pounds sterling annually, for the promotion of art, science, or such other branch of knowledge for which it is associated, to be from time to time certified to the satisfaction of the Board of Governors of the Institute by the Chairman for the time being of the Society.

2. Any Society incorporated as aforesaid shall cease to be incorporated with the Institute in case the number of the Members of the said Society shall at any time become less than twenty-five, or the amount of money annually subscribed by such Members shall at any time be less than £50.

3. The bye-laws of every Society to be incorporated as aforesaid shall provide for the expenditure of not less than one-third of its annual revenue in or towards the formation or support of some local public Museum or Library; or otherwise shall provide for the contribution of not less than one-sixth of its said revenue towards the extension and maintenance of the Museum and Library of the New Zealand Institute.

4. Any Society incorporated as aforesaid which shall in any one year fail to expend the proportion of revenue affixed in manner provided by Rule 3 aforesaid, shall from thenceforth cease to be incorporated with the Institute.

5. All papers read before any Society for the time being incorporated with the Institute, shall be deemed to be communications to the Institute, and may then be published as proceedings or transactions of the Institute, subject to the following regulations of the Board of the Institute regarding publications:

Regulations regarding Publications.

(*a*) The publications of the Institute shall consist of a current abstract of the proceedings of the Societies for the time being incorporated with the Institute, to be intituled "Proceedings of the New Zealand Institute," and of transactions comprising papers read before the Incorporated Societies (subject, however, to selection as hereinafter mentioned), to be intituled, "Transactions of the New Zealand Institute."

(*b*) The Institute shall have power to reject any papers read before any of the Incorporated Societies.

(*c*) Papers so rejected will be returned to the Society before which they were read.

(*d*) A proportional contribution may be required from each Society towards the cost of publishing the proceedings and transactions of the Institute.

(e) Each Incorporated Society will be entitled to receive a proportional number of copies of the proceedings and transactions of the Institute to be, from time to time, fixed by the Board of Governors.

(f) Extra copies will be issued to any of the Members of Incorporated Societies at the cost price of publication.

6. All property accumulated by or with funds derived from Incorporated Societies and placed in the charge of the Institute shall be vested in the Institute, and be used and applied at the discretion of the Board of Governors for public advantage, in like manner with any other of the property of the Institute.

7. Subject to "The New Zealand Institute Act, 1867," and to the foregoing rules, all Societies incorporated with the Institute shall be entitled to retain or alter their own form of constitution and the bye-laws for their own management, and shall conduct their own affairs.

8. Upon application signed by the Chairman and countersigned by the Secretary of any Society, accompanied by the certificate required under Rule No. 1, a certificate of incorporation will be granted under the Seal of the Institute, and will remain in force as long as the foregoing rules of the Institute are complied with by the Society.

Section II.

For the Management of the Property of the Institute.

9. All donations by Societies, Public Departments, or private individuals, to the Museum of the Institute, shall be acknowledged by a printed form of receipt, and shall be duly entered in the books of the Institute provided for that purpose, and shall then be dealt with as the Board of Governors may direct.

10. Deposits of articles for the Museum may be accepted by the Institute, subject to a fortnight's notice of removal, to be given either by the owner of the articles or by the Manager of the Institute, and such deposits shall be duly entered in a separate catalogue.

11. Books relating to Natural Science may be deposited in the Library of the Institute, subject to the following conditions :—

(a) Such books are not to be withdrawn by the owner under six months' notice, if such notice shall be required by the Board of Governors.

(b) Any funds specially expended on binding and preserving such deposited books, at the request of the depositor, shall be charged against the books, and must be refunded to the Institute before their withdrawal, always subject to special arrangements made with the Board of Governors at the time of deposit.

(c) No books deposited in the Library of the Institute shall be removed for temporary use except on the written authority or receipt of the owner, and then only for a period not exceeding seven days at any one time.

12. All books in the Library of the Institute shall be duly entered in a catalogue, which shall be accessible to the public.

13. The public shall be admitted to the use of the Museum and Library, subject to bye-laws to be framed by the Board.

Section III.

14. The Laboratory shall, for the time being, be and remain under the exclusive management of the Manager of the Institute.

LIST OF SOCIETIES

INCORPORATED WITH THE NEW ZEALAND INSTITUTE.

NAME OF SOCIETY.	DATE OF INCORPORATION.
WELLINGTON PHILOSOPHICAL SOCIETY. . .	June 10, 1868.
AUCKLAND INSTITUTE	June 10, 1868.
PHILOSOPHICAL INSTITUTE OF CANTERBURY .	October 22, 1868.
OTAGO INSTITUTE	October 18, 1869.

OFFICE BEARERS OF THE WELLINGTON PHILOSOPHICAL SOCIETY.

1869.

PRESIDENT.
SIR GEORGE GREY, K.C.B.

VICE PRESIDENTS.
HIS HONOR I. E. FEATHERSTON, M.D., Superintendent of Wellington,
J. C. CRAWFORD, ESQ., F.G.S.

COUNCIL.
W. T. L. TRAVERS, ESQ., F.L.S.
R. PHARAZYN, ESQ., F.R.G.S.
W. B. D. MANTELL, ESQ., F.G.S.
J. HECTOR., ESQ., M.D., F.R.S.
J. KEBBELL, ESQ.

HON. SECRETARY AND TREASURER.
R. PHARAZYN, ESQ.

1870.

PRESIDENT.
W. B. D. MANTELL, ESQ., F.G.S.

VICE PRESIDENTS.
J. C. CRAWFORD, ESQ., F.G.S.
R. PHARAZYN, ESQ., F.R.G.S.

COUNCIL.
W. T. L. TRAVERS, ESQ., F.L.S.
J. KEBBELL, ESQ.
J. HECTOR, ESQ., M.D., F.R.S.
W. LYON, ESQ., F.G.S.
W. BULLER, ESQ., F.L.S., F.G.S.

HONORARY SECRETARY, *pro tem.*
R. PHARAZYN, ESQ.

Extracts from the Laws of the Wellington Philosophical Society.

5. Every Member shall contribute annually to the funds of the Society the sum of one guinea.

6. The annual contribution shall be paid in advance, on or before the first day of January in each year.

7. The sum of ten pounds may be paid at any time as a composition of the ordinary annual payment for life.

17. General Meetings for business of Members of the Society shall be held in the evening of one day or more in each quarter (the time and place of meeting to be fixed by the Council, and duly announced by the Secretary), to receive the Secretary's Report, and to carry out the general objects and business of the Society.

OFFICE BEARERS OF THE AUCKLAND INSTITUTE.

1869.

PRESIDENT.

T. B. GILLIES, Esq.

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CAPTAIN F. W. HUTTON, F.G.S.
T. PEACOCK, Esq.
S. J. STRATFORD, Esq., M.R.C.S.E.
THOMAS KIRK, Esq.
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SECRETARY AND TREASURER.

T. KIRK, Esq.

1870.

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SECRETARY AND TREASURER.

T. KIRK, Esq.

Extracts from the Laws of the Auckland Institute.

4. New Members on election to pay one guinea entrance fee, in addition to the annual subscription of one guinea; the annual subscriptions being payable in advance on the first day of April for the then current year.

5. Members may at any time become Life Members by one payment of ten pounds ten shillings, in lieu of future annual subscriptions.

10. Annual General Meeting of the Society on the third Monday of February in each year. Ordinary Business Meetings are called by the Council from time to time.

OFFICE BEARERS OF THE PHILOSOPHICAL INSTITUTE OF CANTERBURY.

1869.

PRESIDENT.

JULIUS HAAST, Esq., Ph.D., F.R.S.

VICE PRESIDENTS.

J. S. TURNBULL, Esq., M.D. | H. J. TANCRED, Esq.

COUNCIL.

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C. DAVIE, Esq.
ED. JOLLIE, Esq.
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HONORARY TREASURER.

J. W. S. COWARD, Esq., L.S.A.

HONORARY SECRETARY.

REV. C. FRASER, M.A., F.G.S.

1870.

PRESIDENT.

JULIUS HAAST, Esq., Ph.D., F.R.S.

VICE PRESIDENTS.

REV. CANON WILSON, M.A. | T. NOTTIDGE, Esq.

COUNCIL.

C. DAVIE, Esq.
R. M. FEREDAY, Esq.
E. JOLLIE, Esq.
H. J. TANCRED, Esq.
W. ROLLESTON, Esq., B.A.
SELBY TANCRED, Esq., C.E.

Extracts from the Laws of the Philosophical Institute of Canterbury.

VII. The Ordinary Meetings of the Institute shall be held every first week during the months from March to November inclusive.

XXV. Members of the Institute shall pay two guineas annually as a subscription to the funds of the Institute.

XXVII. Members may compound for all annual subscriptions of the current and future years by paying thirty guineas.

OFFICE BEARERS OF THE OTAGO INSTITUTE.

1869-70.

PRESIDENT.

HIS HONOR MR. JUSTICE WARD.

VICE PRESIDENTS.

ALFRED ECCLES, ESQ., F.R.C.S.E. | ARTHUR BEVERLEY, ESQ.

COUNCIL.

L. O. BEAL, ESQ.
CAPTAIN FRASER.
ROBERT GILLIES, ESQ.
STUART HAWTHORNE, ESQ.
REV. D. M. STUART.
JAMES SMITH, ESQ.
J. T. THOMSON, ESQ.

HONORARY TREASURER.

W. D. MURISON, ESQ.

HONORARY SECRETARIES.

J. S. WEBB, ESQ. | T. M. HOCKEN, ESQ., M.R.C.S.E.

Extracts from the Laws of the Otago Institute.

3. From and after the 1st September, 1869, any person desiring to join the Society may be elected by ballot, on being proposed in writing at any meeting of the Society by two members, on payment of the annual subscription for the year then current.

4. Members may at any time become life members by one payment of ten pounds ten shillings, in lieu of future annual subscriptions.

9. An annual general meeting of the Members of the Society shall be held on the second Monday of July in each year, at which meeting not less than ten members must be present, otherwise the meeting shall be adjourned by the members present from time to time, until the requisite number of members are present.

16. The Council shall have power to appoint stated times for meetings of the Society and Council, and may from time to time make and alter regulations for the conduct of business at such meetings, for the management of any library or museum belonging to the Society, and generally for the conduct and management of the affairs of the Society and Council.

NEW ZEALAND INSTITUTE.

ANNIVERSARY ADDRESS

OF

THE PRESIDENT,

HIS EXCELLENCY SIR GEORGE F. BOWEN, G.C.M.G.

DELIVERED TO THE MEMBERS OF THE NEW ZEALAND INSTITUTE, AT THE ANNIVERSARY MEETING, HELD ON THE 24TH JULY,

GENTLEMEN,—

It is the well-known duty of the President of every Society, such as is the New Zealand Institute, to open the annual session with a review of the proceedings of the past year, and of the general condition and progress of the Association. This is a deliberate pause, as when a guide, showing a mountainous and interesting country, calls upon a party of travellers to look back on the scenes which they have just passed, and the difficulties which they have already surmounted, and to contemplate the prospect around and before them.

In my Inaugural Address at the opening ceremony of last year, I explained the character and objects of this Institute; and showed that the main object of the Legislature in founding it, was to provide guidance and aid for the people of New Zealand in the practical work of colonisation. The recently published volume of the Transactions and Proceedings of the Institute, and of its affiliated societies, during the first year of its existence, proves that this eminently practical object has been carefully kept in sight; while there is abundant promise of future usefulness. It should here be mentioned that the value of this volume has been considerably increased by the incorporation of a series of Essays, some of which were placed at the disposal of the Governors, in a printed form, having been issued at Dunedin shortly after the Exhibition of 1865, through the indefatigable exertions of the Honorary Secretary, Dr. Eccles. The progress already achieved appears to have been appreciated

throughout the Colony; for a large accession has lately taken place to the number of members of the affiliated societies; while new societies have been organized, and propose to seek incorporation.

As the first volume of our Transactions has been for some time in the hands of the members of the Institute and of the public, it is only necessary for me to refer briefly to some of its more prominent contents. It cannot fail to be generally acknowledged that the records of the proceedings of the several departments are remarkable for the great variety of topics which they embrace. And here I should mention that the brilliant essay by Mr. Fitzgerald, to whose eloquence we all listened with delight, has been, by his own desire, reserved for the volume to be published next year.

Among the less formal communications embodied in the printed Proceedings, we observe practical suggestions concerning building materials, agricultural processes, and metallurgy; on the preparation and manufacture of the indigenous flax *(Phormium tenax)*, which is rapidly becoming an important industry in this Colony; notices of the results of the chemical analyses of a great variety of vegetable and mineral productions; and records of the striking natural phenomena that occurred during the past year.

The communications published at length afford elaborate information; and I will now glance at a few of the chief points of interest which they present.

The first paper, by Mr. Crawford, calls attention to some obscure phenomena respecting erratic boulders in the North Island, which appeared to him to have required the intervention of ice to effect their distribution. Considering the vast extent of surface over which the operations of that mighty ice tool, the glacier, have recently been recognized in the Northern Hemisphere, our geologists should search closely for similar evidence in all the mountain centres of New Zealand. Dr. Haast, and other explorers, have shown that in the South Island there are still glaciers rivalling in magnitude those of the Alps of Europe; that in former ages they were even of greater extent, and that there are no sufficiently marked differences in the climate of this country to warrant the assumption that glaciers could not have existed at some remote period, in valleys radiating from the mountains, which are even now visible from Wellington, as ranges covered with snow during several months of the year. It appears, indeed, that so lately as in 1863, an avalanche of ice forced its way for a distance of seventy miles, from Ruapehu, in the centre of this island, to the sea, by the Wangaehu river.

Mr. Mantell's address on the Moa, is particularly valuable, as embodying the results alike of his scientific knowledge and of his extensive researches. Many of you, gentlemen, have had the pleasure of inspecting the group of skeletons of the Moa in the Christchurch Museum. The effect is very striking and suggestive; and when we consider that these are stated by

Dr. Haast in his paper on the Measurements of the Moa, to be but a few, selected from the remains of nearly two hundred skeletons obtained within a small area in the Province of Canterbury, we are enabled faintly to imagine the strange appearance of this country when these gigantic birds roamed over it in large flocks.

The admirable paper by Mr. Travers, dealing with the principles involved in the discrimination of the various species of plants, proves that our local botanists are co-operating with those of Europe in settling many of the higher questions of their science. In another paper, Mr. Travers has applied his botanical knowledge to a very practical purpose, by an able dissertation on the manufacture of the New Zealand flax. Sir David Monro has also contributed to the botanical literature of this country, an Essay as charming in style as it is valuable in substance.

I will not recall the disagreeable sensations which the earthquake waves caused in last August, by commenting on the descriptions given of them by Dr. Hector and Dr. Haast, beyond congratulating the members of the Institute in having the facts so well recorded in our Transactions, concerning phenomena which have excited a world-wide interest. In this, as in many other respects, our acknowledgments are due to the accomplished Director of the Museum, Dr. Hector, who is also the editor of our Transactions.

Time and space will permit me only to glance at several other interesting papers, such as those of Mr. Colenso, respecting the History, Language, and Customs of the Maoris; of Mr. Buller, and Captain Hutton, on Ornithology, the former of which has called forth a critique from Professor Finsch of Bremen, and a rejoinder by the author, all of which appear in the volume; of the Bishop of Wellington,* on the Celtic origin of the English vowel sounds; of Mr. Dobson, on the Present State of Applied Science in the Province of Canterbury; of Mr. Henry Travers, respecting the Chatham Islands; of Mr. Kirk, on the Flora of several parts of the Province of Auckland; of Captain Vine Hall, on the Island of Rapa; of Mr. Pharazyn, on the Taranaki Iron Sand. I would also direct attention to the Inaugural Address delivered to the Auckland Society, by its first President, Mr. Whitaker, as I have stated on a previous occasion, "Co-operation is the secret of success in all scientific pursuits; and the New Zealand Institute, while leaving its affiliated societies unfettered in the performance of their separate functions, will publish their chief transactions on a uniform plan, thereby concentrating the information collected by local observers throughout the country, and providing for the preservation, in a permanent and accessible form, of the result of their labours."

Passing from the records in the annual volume, it now seems desirable to notice briefly the progress which has been achieved during the past year, under the auspices of the Institute, in various points of practical and scientific enquiry.

1. The establishment of a uniform system of time, to be observed throughout the Colony, in pursuance of a decision of the Legislature to that effect, has rendered necessary the erection of a small Observatory, which is now nearly complete.

2. The attention of the Government having been solicited by Commodore Lambert, to the expediency of a more accurate determination of the longitude of this Colony, a Board has been appointed to take advantage, for this purpose, of the above-mentioned Observatory. As this establishment will be in communication, by electric telegraph, with all other stations, it may be rendered available for determining the differences of longitude between the several parts of these Islands.

3. Much practical interest attaches to the accurate investigation of the prevailing currents of the ocean, and the ends of science would be promoted by taking systematic observations with the thermometer and dredge round the New Zealand coasts. Some progress has already been made in this direction, and we may confidently rely on the co-operation of the Admiralty, in this, and in all other enquiries of a similar nature.

4. The reports of the Meteorological Department show, that the machinery for carrying out this important branch of research is now thoroughly organized, and that full dependence may be placed on the results, as affording an exact comparison of the climate in the several districts of these Islands. Meteorological data, respecting the southern latitudes, will be of great assistance to the expeditions organized to visit these seas in 1874-1882, with the special object of making astronomical observations of the same kind as those, which first, one hundred years ago, led Captain Cook to this quarter of the globe. It should never be forgotten that it was an expedition planned for the purpose of one scientific determination, which ultimately brought about the settlement of the entire group of the Australian Colonies.

5. From the reports of the Geological Department it will be seen that fossils have been obtained which will facilitate the comparison of our coal strata with those of the neighbouring Australian Continent; also, that New Zealand is not without representatives of the secondary formations, containing the remains of gigantic reptiles, similar to those occurring in England, and so familiar to us through the writings of Buckland and Mantell.

To the same department belong Captain Hutton's Reports on the Thames Gold Fields, showing, in a clear and suggestive manner, the wonderful development of that district.

I have already detained you too long, and can now only allude to many more interesting subjects; among others, to the efforts of the several Acclimatization Societies already established in New Zealand. We may confidently hope that, sooner or later, they will be as successful in introducing the salmon and other fish, as they have already proved in introducing so many of the animals and birds of the Old World.

In concluding this imperfect sketch, it would be unpardonable to omit a further and fuller reference to the fact, that this is the hundredth year since the arrival, in New Zealand, of Captain Cook. He landed for the first time in this country, in October, 1769, at Turanganui, which he afterwards named Poverty Bay,—apparently because the ferocity of the Natives of that district (of which we have lately had fresh and terrible experience), prevented him from obtaining water and other supplies for his crew. When, some months ago, I visited Turanganui, and stood on the spot where tradition reports that the illustrious navigator first set his foot on these shores, the thought struck me that it would have cheered his gallant spirit, amidst his many dangers and distresses, if his imagination (a faculty seldom wholly wanting in great men) could have portrayed the future destiny of the *Terra Australis*—of the vast Continent and Islands of the Southern Ocean—previously invested, like the fabled Atlantis of old, by the reports of the early Dutch and Spanish navigators—with a dim and mysterious interest, but which Cook first made practically known to his own countrymen, and, through them to the civilized world. It would, however, have required prophetic inspiration to foretell, that in the "Great Southern Land," in which Cook first recommended the foundation of British settlements, there would arise, within less than a century after that recommendation, a British Empire, embracing a territory nearly as large as Europe, and already far surpassing in wealth, in trade, in all the arts which advance and adorn civilization, those American colonies, which, a hundred years ago, were on the eve of renouncing their allegiance to the mother country. It need scarcely be mentioned, among the many obvious proofs and illustrations of these statements, that, in 1769, the trade of all the Colonies which now form the American Republic and the Dominion of Canada, did not much exceed in value three millions sterling yearly; whereas the trade of New Zealand alone now reaches nearly ten millions sterling, while the annual trade of all the Australasian Colonies reckoned together amounts to sixty millions sterling. Again, the richest and most populous city in North America, a century back, was Boston, which, though then more than one hundred and fifty years old, contained only 20,000 inhabitants. Now, in 1869, Melbourne, the largest and wealthiest city in the southern hemisphere, though barely thirty-five years old, contains not far from 150,000 inhabitants.

Many here present must be familiar with the celebrated passage in one of the most eloquent speeches of Edmund Burke, where the aged statesman, Lord Bathurst, is supposed to have foreseen, in his youth, with the aid of a heavenly guide, the rise of American colonization from insignificance to greatness during his own lifetime—that is, during the first seventy years of the eighteenth century. "Suppose," said the brilliant orator, "that the angel of the auspicious youth, foreseeing the many virtues which made him one of the most amiable, as he is one of the most fortunate, men of his age, had

opened to him in vision, that when in the fourth generation, the third Prince of the House of Brunswick had sat twelve years on the throne of that nation, which (by the happy issue of moderate and healing councils) was to be made Great Britain, he should see his son, Lord Chancellor of England, turn back the current of hereditary dignity to its fountain, and raise him to a higher rank of peerage, whilst he enriched the family with a new one. If amidst these bright and happy scenes of domestic honor and prosperity, that angel should have drawn up the curtain and unfolded the rising glories of his country; and whilst he was gazing with admiration on the then commercial grandeur of England, the genius should point out to him a little speck, scarce visible in the mass of the national interest, a small seminal principle, rather than a formed body, and should tell him: 'Young man, there is America, which at this day serves for little more than to amuse you with stories of savage men and uncouth manners, yet shall, before you taste of death, show itself equal to the whole of that commerce which now attracts the envy of the world. Whatever England has been growing to, by a progressive increase of improvement, brought in by varieties of people, by succession of civilizing conquests and civilizing settlements in a series of seventeen hundred years, you will see as much added to her by America in the course of a single life?' If this state of his country had been foretold to him, would it not require all the sanguine credulity of youth, and all the fervid glow of enthusiasm, to make him believe it? Fortunate man he has lived to see it!" . . . I need not remind you that the progress of America during the first three quarters of the eighteenth century, which appeared so wonderful to the statesmen of that age, was insignificant when compared with the progress of Australia and New Zealand within the memory of many of those whom I now see around me.

The centenary of the first arrival of Captain Cook in these seas has been commemorated at Sydney by the erection of a statue in his honor. The foundation stone of the pedestal was recently laid by the Duke of Edinburgh, the great grandson of that sovereign whom Cook had proclaimed the lord of this mighty segment of the globe. On that occasion His Royal Highness spoke in words that well deserved to be recorded, as follows:—"One of the happiest privileges which the members of the Royal Family enjoy is, that of being able to do honor to the memory of great men and of noble deeds, by their presence at such a ceremony as that which we are met to perform to-day. But when the man whose fame we desire to commemorate, has, by a life of great discoveries and of scientific research, increased so materially the territorial extent of the empire, and has conferred so great benefits upon the whole civilized world by his valuable additions to geographical knowledge, and when, by these noble actions he has shed a lustre upon the profession to which he belonged, and to which I am so proud to belong—I mean the maritime service of the greatest maritime nation of the world—then indeed I feel that a

very high honor is conferred upon me in having my name associated with this memorial of his greatness. There is no one among the names of England's heroes more deserving of this recognition on your part, and none whose career could be held up as a brighter example to every Englishman, than that of Captain Cook. Humble as his origin was, he possessed that true nobility of character, which has for its object, not the aggrandizement of self, but the welfare of the nation. He is among the chief of those who, in making Englishmen proud of their name and of their mother country, have helped to cement in one powerful brotherhood the subjects of the British Empire in every part of the world. In conclusion, I trust that there are many among the sons of Australia who will emulate his example, and gild with noble deeds the name of this great country, and the fame of England."

Had the present circumstances of this country permitted it, the Duke of Edinburgh would have been requested, on behalf of the New Zealand Institute, to join with us in some similar celebration. There can be no doubt, but that the time will come when there will arise in this country, as at Sydney, a monument to the memory of Captain Cook. Meanwhile, let us at least place on record, among the Transactions of the Institute, that we are not forgetful that this is the hundredth anniversary of his first arrival in New Zealand; and that we yield to no community of our countrymen, elsewhere, in admiration for his character, and for the magnificence of his achievements. It has been truly remarked that Cook, as a seaman and navigator, occupies the first rank in nautical history and science; and that later mariners and observers, though they have added to his discoveries, have rarely found it possible to dispute them. In his charts and journals nothing is uncertain, nothing is irrelevant, the modern investigator starts from them as from authorities of undoubted accuracy. A few years ago, I had myself a favorable opportunity, in concert with the late lamented Commodore Burnett, during our voyage of 1,200 miles along the eastern coast of Queensland, from Moreton Bay to Cape York, of verifying the vivid truth of Cook's observations. Every bay and headland was, at first sight, easily recognized from his graphic descriptions, often from the picturesque and somewhat humorous names, for example—Cape Upstart, Cape Bowling Green, the Glasshouse Mountains, and the like, which he had assigned to them. In a word, the fresh explorations of every year display more fully the value of Cook's discoveries, and the almost prophetic foresight with which he was guided and inspired. It has been said, without any exaggeration, that he stands forth as the founder of a new era in nautical discovery, and as the revealer of a new world.

TRANSACTIONS

OF THE

NEW ZEALAND INSTITUTE.

1869.

TRANSACTIONS

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NEW ZEALAND INSTITUTE.

1869.

I.—NATURAL HISTORY.

ART. I.—*On the* NEW ZEALAND SWORD-FISH. By F. J. KNOX, L.R.C.S.E.

(With Illustrations.)

[*Read before the Wellington Philosophical Society, June* 19, 1869.]

AT a meeting of the Wellington Philosophical Society, held September 15, 1868, I communicated a brief notice of the cranium and other portions of a Sword-Fish (*Xiphias*, Linn.), presented by me to the Museum, which was read, with the supplementary note by Dr. Hector. (See "Trans. N. Z. Institute, Vol. i., page 44.) I now communicate the further details which were then promised.

The specimen had been stranded on the west coast of the North Island, near Waikanae, in the month of June, 1867. Like most other strangers, this fish attracted immediate attention, and was so cut up that I was only able to procure the preparations now in the Museum, which are insufficient to enable me to determine, with anything like precision, the particular species. From Dr. Günther's catalogue of the Acanthopterygian fishes in the collection of the British Museum, it appears that there are eight different specimens, divided into two genera :—

1. Xiphias, ventral fins, none.
2. Histiophorus, ventral fins, present.

Now, the portion I procured being only the cranium and anterior part of the dorsal fin, it is impossible to determine even the genus, with anything like scientific precision. In the meantime, I may remark that in *Xiphias gladius*, according to Dr. Günther, there are "*no* teeth, neither in the jaws nor on the palate," whilst in the *Histiophorus, there are small teeth in the jaws and on the palatine bones ;* and it is important to remark that Cuvier (McMurtrie's

Translation, 1834) does not mention the presence of teeth. This, if correctly stated, would place the specimen in the genus *Histiophorus*, as the entire interior of what may be considered the buccal cavity, is covered with almost microscopic teeth, so placed, that the food (supposed by me to consist chiefly of the cuttle fish), when seized or impaled, cannot escape. I would add, that Dr. Günther, in his description of the specific characters of the *Histiophorus*, as distinguishing it from *Xiphias*, says "*small teeth in the jaws and on the palate bones; none on the vomer.*" Now the teeth, in the specimen before the Society, are developed on the mucous membrane covering the hard palate and lower jaw, and are, in no sense, *in the jaws;* so that if the specimen described by Dr. Günther had been macerated, and the osseous surfaces denuded of the mucous membrane and periosteum, there would not have been the vestige either of teeth or socket. I find from a specimen of the eel and hapuka, now on the table, that the system of dentition strictly resembles that of the Sword-Fish (*Histiophorus*). The teeth are so placed as to be pointed from before backwards, allowing the food, or the finger, to pass towards the throat without obstruction, but rendering a retreat impossible, at least in the living animal, when feeding, and probably very hungry. This is probably intended to compensate for the want of cutting (incisor), holding (canine), grinding (molar) teeth. The muscles acting on the jaws (temporal and masseter) are of enormous size, red in colour, and resembling the muscles in the carnivorous mammalia.

When I left Scotland, in 1840, there was, in my brother's private museum, undoubtedly the finest and most extensive collection of the skeletons of fishes in Europe, amongst others, the skeleton of a Sword-Fish. The specimen was taken in the Firth of Forth, and after exhibition, was purchased by my brother. A hurried examination of the anatomy was made, and I think plaster casts of the viscera taken—which, I may remark, is an admirable mode of preserving. The preparation of the skeleton was handed over to me. It proved rather a heavy affair, owing to the complete saturation of every texture with a fine fluid oil. It was too large for any of the glazed cases in the museum, and was accordingly placed on the top of the cases. I may state that this skeleton always appeared to me to present rather an ideal, than a natural, form, as it seemed out of proportion, and deficient in framework.

The fragments I have now presented to the Colonial Museum, are part, therefore, of the second specimen that has come under my personal notice.

In Dr. Günther's Catalogue, Vol. ii., 1860, the *Xiphiidæ* form the eighteenth family of the *Acanthopterygian*, or soft-finned fishes, divided into two genera, containing eight species. The British Museum appears to possess only the following specimens:—

I. Xiphias.

Gladius—

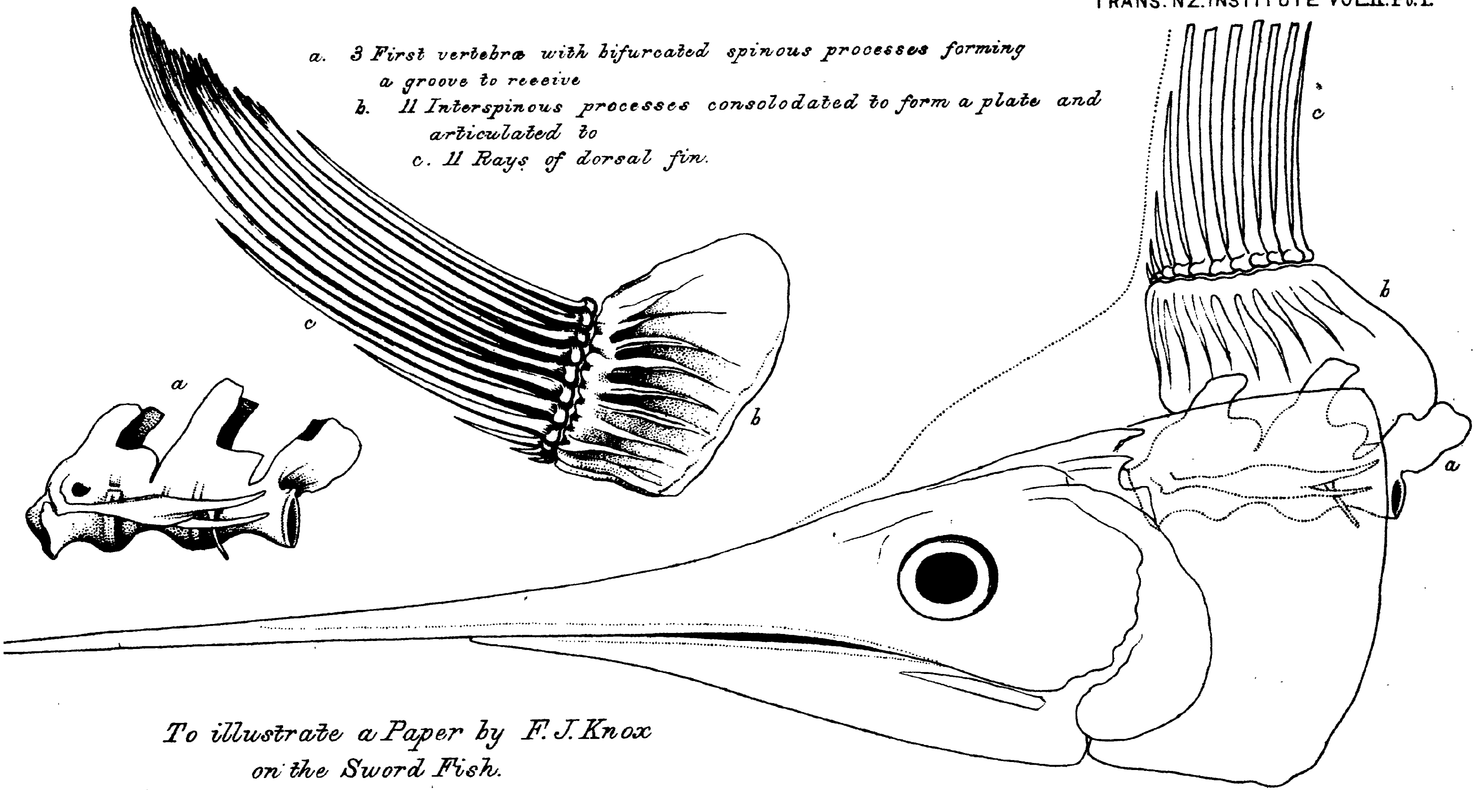
(*a.*) Seven feet long. Stuffed. Margate.
(*b.*) Half-grown. Stuffed.
(*c.*) Upper jaw of a large specimen.
(*d.*) Six inches long. Not a good specimen. Caught in Long. 22° W., Lat. 2° N. Presented by J. B. Jukes, Esq.

II. Histiophorus.

Herchellii—

(*a.*) Eleven feet long. Stuffed. Table Bay. Purchased of Mr. Smuts. Type of the species.
(*b.*) Head (thirty-seven inches long).
(*c.*) Anterior portion of a skull of a specimen of the same size.

a. 3 First vertebræ with bifurcated spinous processes forming
a groove to receive
b. 11 Interspinous processes consolodated to form a plate and
articulated to
c. 11 Rays of dorsal fin.



To illustrate a Paper by F. J. Knox
on the Sword Fish.

J. Buchanan del. & lith.

Printed at the Gen. Gen. Lith. Press by J. Earle.

Gladius—

(*a.*) Eight feet long. Stuffed. Indian Ocean. Type of species.
(*b.*) Seven feet long. Stuffed. Cape of Good Hope.
(*c.*) Dorsal fin. New South Wales (?). Presented by Dr. G. Bennett.
(*d.*) Snout. Dried.

In quoting the numerous authorities describing the species, Dr. Günther, amongst others, includes:—Penn., British Zool., iii., p. 216, pl. 30; Knox, Edin. Journal; Nat. and Geo. Society, ii., p. 427.

Thus the material for scientific observation in the British Museum is extremely limited, with regard to the *Xiphiidæ*. I may here remark, that in my brother's (the late Professor Robert Knox) description, the comparative anatomy would, to a certainty, be given; and if so, I would have thought Dr. Günther would have availed himself of it.

INTEGUMENTARY COVERINGS AND DERMAL PRODUCTIONS.

The portion of the integuments, placed in the Museum, occupied the anterior part of the dorsal line, corresponding to the neck, reaching from the head, to and past the dorsal fin. I observed no appearance of scales; the whole resembling coarse leather, and so formed as to require a saw to cut it. The tissue thus forms a regular coat of mail made of spiculi of bone so interwoven with the integumentary tissues, as to be completely concealed. I should consequently, imagine this fish to be perfectly secure from any enemy, in or out of the water.

The dorsal fin is, undoubtedly, a striking feature in the *Xiphiidæ*, and the *caudal* fin, in the specimen to which I have alluded in my brother's collection, was also prominent. At a first view, it was as if formed of two dorsals, and if included in the length of the fish (which is generally done by naturalists), would have added a foot or more to the total length.

By the very limited observation I could make on the specimen now under review, owing to the non-scientific dissection it had been subjected to before I got it, I found the dorsal fin capable of being moved, to a very considerable extent, in all directions. The interspinal processes (b, Plate 1) are firmly united to each other, presenting a free articular surface to the rays of the fin; and when acted upon by the powerful muscles of the back, will act as a sail, and an oar, the brain being the steersman, the tail, no doubt, answering the cerebral instinct, voluntary or not. The longitudinal fissure seen in the specimen is not the result of dissection, but natural; and is lined by a delicate soft membrane, a continuation of the same covering immediately investing the rays of the fin. The spinous processes of the vertebræ, when examined, will be found bifurcated (c, Plate 1), forming a groove or slide for this unique action of the dorsal fin in the *Xiphiidæ*. In many fishes, however, the spinous rays can be depressed, and again erected, at the will of the fish.

The following measurements and weights of the specimen now deposited in the Colonial Museum, were observed before and after their preparation:—

	lbs.	oz.
Weight previous to dissection:—Head, including anterior half of the dorsal fin, *but without any portion of the bronchial apparatus*	29	8
Lower jaw	2	8
Total weight	32	0

Measurements.

	lbs.	oz.
Snout to gape	2	5
„ to nostrils	2	0
„ to centre of eye	2	3
„ to opercula (free edge of)	3	3
„ to dorsal fin	3	0
Tip of lower jaw to gape	1	4
Projection of upper jaw (the sword)	1	1
Circumference at dorsal fin	3	4
„ over eyes	2	4
Depth from base of dorsal fin to free edge of opercula	1	4
Height of dorsal fin	1	4

(Specimen deposited in the Museum, January 10, 1867.*)*

Weights.

	lbs.	oz.	grs.
Head, including lower jaw	8	0	0
Dorsal fin (anterior half of), including interspinal processes	0	12	0
Eyes (two) sclerotic tunic ossified	0	7	0
Lens (two) dry	0	0	80
Total weight of the osseous portions	9	3	80

Diameter of eye, 3 inches 6 lines.

Abstract of Weights.

	lbs.	oz.	grs.
Total weight of recent specimen	32	0	0
„ of osseous portions	9	3	80
„ of soft parts	22	12	40

CERVICAL VERTEBRÆ.

		in.	lines.
Length of body	1st vertebra	2	0
	2nd „	2	6
	3rd „	2	6
Breadth of articular surface		1	6

RIBS.

Length	1st rib	7	0
	2nd „	5	0
	3rd „	2	6

INTEGUMENTS.

Portion belonging to the neck, and consequently connected with the dorsal fin.

Art. II.—*On the* Tuatara (*Hatteria punctata,* Gray); *or Great Fringed Lizard of New Zealand.* By F. J. Knox, L.R.C.S.E.

[*Read before the Wellington Philosophical Society, July* 17, 1869.]

By the kindness of Dr. Hector, I have been enabled to peruse a recent minute description of the *Tuatara,* or Fringed Lizard. I take the more interest in this truly scientific memoir of Dr. Albert Günther, as it brings to my recollection a circumstance which occurred, now twenty-six years ago. In 1842, a family of the name of Houghton resided on Somes' Island, and, amongst the usual accompaniments of the human family, had a few rabbits. The family shortly after left the island, and took up their residence in Wellington. On leaving, a daughter of Mr. Houghton missed a favourite rabbit, and commencing a thorough search, put her hand into one of the numerous sand holes, and grasped what she joyfully supposed to be her lost rabbit, but found it was a live specimen of the *Tuatara.* The specimen lived for some time, but receiving—owing to the very primitive condition of the colony—by no means the attention it deserved, it died; and I attributed its death to too sudden an exposure to the noonday sun. I however was enabled to anatomise it. The skeleton, more especially, was preserved with the greatest care, and so much of its anatomy as would preserve was sent to the British Museum.

Until lately, I have never seen another specimen, but many have, however, been procured since the establishment of this Museum. I am now able to bring under the notice of the Society, the result of a careful anatomical examination of two specimens. These observations have been drawn up from my notes on the original specimen sent to the British Museum, in 1842, and from the dissection of the two specimens placed at my disposal by Dr. Hector, the skeletons and soft parts of which I have placed in the Museum. Both specimens were females; the ova varying in size from almost microscopic, to two lines in diameter, and thus indicating a maturity in the individual specimens.

I shall now state a few of the points in which I differ from Dr. Günther.

1st. In the description of the head, it appears to me that he has lost sight of the basis on which all researches in "comparative anatomy" is founded, *i.e.,* that of man, as compared with other animals, and adopts a nomenclature of such complexity, as would confine the future investigations into the history of the animal creation, to the mere compiler, the *closet* naturalist. I take as a sample the *os quadratum,* p. 4, which he describes as a distinct elementary bone, without stating that it is merely a portion of the human temporal bone. The scientific anatomist, in his researches into the structure of the animal kingdom, knows that the temporal bone undergoes almost innumerable changes during its development from the embryo, and is composed, even at an advanced period of life, in man, of various separate centres of ossification, deposited in a cartilaginous basis; in fishes, uniting with other bones of the cranium; in birds, remaining separate; in reptiles, uniting with other bones, but still readily recognizable as being that centre of ossification in the temporal bone in man, articulating with the lower jaw.

The vomer (p. 5) is another example in which Dr. Günther evidently proposes to give a new nomenclature to every animal.

As a comparative anatomist, I should look for the vomer in all animals as forming the mesial division between the right and left nostrils; for instance, in the Cetacea (adult) I find an extensive union, and even a difficulty in naming the bones after the universally received type; but it matters not, provided the bone forms the division of the nostrils, and thus performs the

function of the human vomer. I have before me, at this moment, the skeleton of the Gallaxias, in which the bones of the cranium defy any precise nomenclature.

The Tuatara, and other nearly allied species, show a structure in the osteogenesis, or growth of the vertebræ, which does not appear in any other class of the vertebrata. I allude to the supposed power of reproduction of the caudal vertebræ when mutilated. In one of the specimens before the Society, it will be observed that the 34th vertebra is distinctly divided in the middle into an anterior and posterior portion; and I have observed, in the preparation of the skeleton, that it is at this part that the tail gives way, and not, as might be supposed at a joint.

Scientific anatomists have, for fifty years and upwards, satisfied themselves that the cranium is simply a continuation of the vertebral column; and three to seven have been selected as the probable number of vertebræ thus *specialized*, more or less, in the various formations. If, however, the very earliest type of a vertebra is to be seen in the caudal vertebræ of the lizard, such difficulties as Dr. Günther has found in the osteology of the Tuatara, will be more easily understood.

In a subsequent paper on the Green Lizard, which I hope to have the honour of reading to the Society, I shall allude more fully to this very interesting enquiry. I shall be able to demonstrate, that should the tail suffer mutilation, the injured part will, no doubt, heal over, but will not reproduce distinct vertebræ. I draw this conclusion from the careful examination of the specimen of the Green Lizard, which I deposited in the Museum, in 1862.

The caudal vertebræ, in most animals, become rudimentary, reduced, in short, to the centrum or body of the bone; and it was at one time the universal practice to dock the tail and ears in dogs, and even in horses, these mutilations were permanent deformities, and never reproduced.

As I shall add to this short notice carefully drawn up tables of weights and measurements, etc., I shall not detain the Society with any further minute remarks, with the exception of teeth, in which I find so marked a difference, as to constitute a distinct species from those Dr. Günther has described. The Tuatara is an *acrodont;* the teeth being, as it were, chiselled out of the bone.

The intermaxillary bones, Dr. Günther describes, as each supporting a single tooth, "notched, or serrated, at the crown in individuals of middle age;" and he gives an engraving, not only of the young, but of the middle-aged specimen, where there appears only a single notch, given with two points. In one of the two specimens I have prepared, this description corresponds, but in the other I find each tooth divided by two notches into three pointed cones. Thus, the superior maxillary supports, what appears to me, six teeth on each side, including the intermaxillary, of a similar description, each notched into three points. And as a great difference from Dr. Günther's description, I find three on the posterior part of the palatal plate of the maxillary bone similarly notched, separated by a deep groove from those on the alveolar edge. The teeth in the lower jaw admit of easier description: on each side of the symphysis, I observe, as in the intermaxillary, a tooth notched into three points; the outer point slightly diverges, and represents a canine tooth, scarcely visible at first, but increasing in size to a line in length. The system of dentition would therefore stand thus:—

Upper jaw, alveolar edge	$6 + 6 =$	12
,, palatal plate	$3 + 3 =$	6
Complex teeth . . .		18

Lower jaw, complex teeth	1 + 1 =	2
,, alveolar edge, simple teeth	14 + 14 =	28
		30

No. 1 Skeleton.

	oz.
Weight of animal	6

Measurement.

		in.	lines.
Snout to cloaca		7	6
Cloaca to tip of tail		7	0
Total length	1	2	6

VERTEBRÆ.

Cervical	8
Sternal	3
Abdominal	11
Lumbar	3
Sacral	2
Coccygeal	23
Total number	50

No. 2 Skeleton.

	oz.	grs.
Weight of animal	6	120

Measurement.

		in.	lines.
Snout to cloaca		7	6½
Cloaca to tip of tail		8	11½
Total length	1	4	6

VERTEBRÆ.

Cervical	8
Sternal	3
Abdominal	11
Lumbar	3
Sacral	2
Coccygeal	36
Total number	63

Weight of skeleton . . . . . . 306 grains.

Remarks.—The *hæmapophyses* (V-shaped bones) I observe, throughout the whole spinal column, connected with the inter-articular cartilages; in neck, rudimentary (but formed of three points of ossification), disappearing along the

thoracic, abdominal, lumbar, and sacral vertebræ, but again appearing between the thirty-fourth and thirty-fifth vertebræ, rapidly increasing in size, (forming a safe canal for the blood vessels), and gradually decreasing, together with the *neural* and articular processes, until the *centrum* appears like a minute cylinder, divided in the middle of its length, indicating the part which gives way when the tail is accidentally injured. This fissure can be observed in the thirty-eighth vertebra, and a separation may consequently take place in any of the remaining vertebræ. From the peculiar form of the *medulla spinalis*, I feel assured, that when injured, the complete vertebræ will not be reproduced, but will present the appearance as seen in the skeleton No. 1, in which the total number of vertebræ is fifty; and the termination of the tail is composed of a deposit of earthy matter of about one inch in length. The series of triangular processes, considered by Dr. Günther as true ribs,—similar to the false or floating ribs in the mammalia—appear to me, after a careful removal of the integuments, to be dermal productions, much resembling those rib-like processes as seen in the engraving of the Plesiosaurus.

ART. III.—*On the Anatomy of the* NAULTINUS GREYII, Gray, *or Brown Tree Lizard of New Zealand.* By F. J. KNOX, L.R.C.S.E.

[Read before the Wellington Philosophical Society, August 14, 1869.]

DURING the month of January, 1862, a specimen of this reptile was sent to me by a friend, and I examined it with great care. Many points of great interest presented themselves to me, more especially the separation of the tail. In an animal so highly organized, *more especially in the skeleton*, it appeared to me to be an impossibility, that the complex mechanism of so important a part of the animal economy should be suddenly removed, and not only the life of the animal in no way jeopardized, but that the tail, in its entirety, would be reproduced. Nay, more, that the animal had been seen, after the violent separation of the tail, to search for it, and stick it on again! I found, on careful dissection, that the statement, in so far as the detaching of the tail from the body, was correct, but that the separation not only occurred at a particular part of the spine, but presented an obstacle to its regeneration, which appeared to me, and still appears, impossible. I found the divided or separated surface finely dovetailed; the one (proximal extremity of the skin) presenting no dentations, but a perfectly smooth margin; the scales surrounding the part arranged in symmetrical order, whilst on the separated part or tail, eight wedge-shaped processes projected beyond the skin of the tail. (See preparation of the dried skin.) These eight processes were entire, and not caused by a tearing process, but were arranged in pairs:—

Dorsal margin	1 pair
Abdominal margin	1 „
Lateral margin	2 „
Total . . .	8

As I attentively observed the separation of the tail, I found that a delicate white cord was gradually leaving a canal in the tail portion. This I recognised to be the *medulla spinalis* (see preparation in phial), and necessarily rendered, in my belief, the power of reproduction still less possible. I may add that the tail in the living animal is in no respect brittle, as stated by some

recent authors, but elastic and prehensile. The food of the *Naultinus Greyii* I found to consist of insects of the *Orthoptera* order.

I conclude this short notice by drawing the attention of the Society to the remarkable similarity in the skeletons of the *Naultinus Greyii*, and the *Tuatara*.

LIZARD.—1862.—*External characters.*

Total weight . . . . 260 grains.

LENGTH.

	in.	lines.
Snout to cloaca	3	6
Cloaca to tip of tail	4	0
Total length .	7	6
Snout to nostrils	0	1
„ to centre of eye	0	5½
„ to cleft of mouth	0	7½
„ to ear	0	10
Greatest circumference round the abdomen . .	2	0

ART. IV.—*On the* BALÆNIDÆ *or Whales with Baleen.* By F. J. KNOX, L.R.C.S.E. *With Notes on the Cetacea, in the Colonial Museum, Wellington,* by DR. HECTOR, F.R.S.

(With Illustrations.)

[*Read before the Wellington Pilosophical Society, September* 18, 1869.]

Observations on the Natural History of the Balænidæ, or that division of mammiferous animals called Cetacea, having the remarkable substance known in commerce as Whalebone (Baleen), as a substitute for teeth.

THE habitat of the Cetacea has necessarily rendered it a difficult task to obtain reliable descriptions of them. The naturalist and practical whaler know nothing about the anatomy of the animal, and they accordingly record measurements of the external surface. In those Cetacea of large size great inaccuracy occurs even in obtaining this very deficient character in determining genera or species. For example, in describing Cetaceans, the naturalist and practical whaler invariably include the tail in their measurements, thus adding from ten to fifteen feet to the actual length of the skeleton; and when the sex and age of the animal are also not given, the result must be the erroneous increase in the number of species. Hence, a carefully prepared skeleton, the sex of the specimen, and, if possible, the anatomy of the viscera, are imperatively required to enable the naturalist to determine with accuracy either genera or species.

The following observations are the result of the dissection of three specimens of the Balænidæ; and the author proposes to reduce the number of Balænidæ to four, distinguished by the following characters:—

	Average length of adult animal.
Balæna Mysticetus, or Right whale . .	55 to 65 feet
Rorqualus major (Knox), Hump-back .	80 to 100 „
„ *minor* (Knox)	20 to 25 „
„ *Sp.*, Trigger-fin, Sulphur-bottom	30 to 55 „

NUMBER OF VERTEBRÆ.

	Cervical.	Dorsal.	Lumbar and Caudal.	Total.	NUMBER OF RIBS.
Balæna Mysticetus .	7	12	33	52	12
Rorqualus major .	7	15	43	65	15
„ *minor* .	7	11	30	48	11
„ *Sp.* Trigger-fin, anatomy not known.					

Baleen—Measurement of longest blade.

Balæna Mysticetus	from 9 to 17 feet
Rorqualus major	from 4 to 5 „
„ *minor*	5 inches
„ *Sp.* Trigger-fin, anatomy not known.	

Average length of Baleen offered for sale, from 6 to 12 feet.

1. Balæna Mysticetus, Right Whale.

The Mysticetus, in point of value, not only exceeds that of all others, not excepting even that of the Cachalot, but is infinitely more valuable, as a marketable production, than any other animal; and yet only the skin (*i.e.*, the blubber of the practical whaler) and its appendages, in the shape of baleen, is brought to market, the entire carcase and skeleton have as yet no marketable value.*

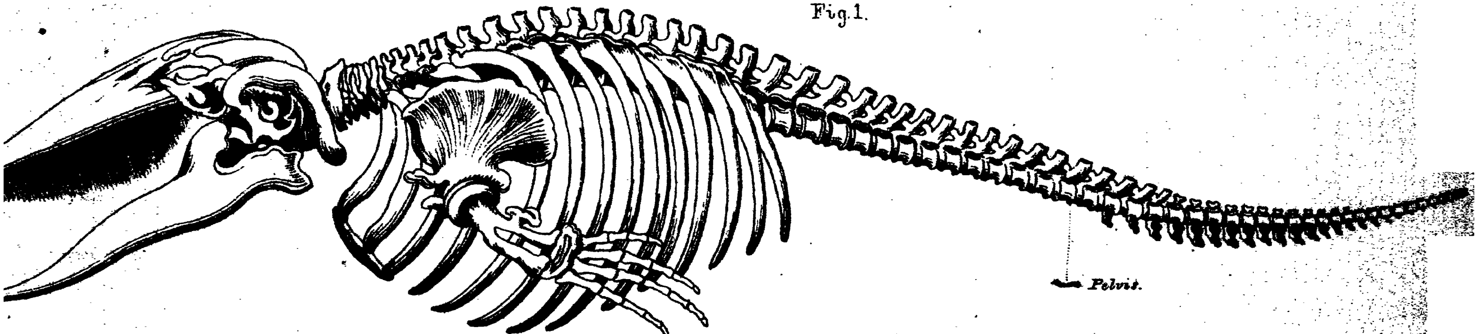
All attempts to give a drawing of the animal have hitherto failed, although the skeleton may now be seen in most of the Museums on the Continent, more especially in Paris, where the Museum, towards the close of Cuvier's career, formed the largest "Scientific Dictionary, illustrated," in the world. (A profile view of the skull is given in Plate 2b, fig. 5.) It has been stated that Cuvier found specific difference between the Arctic and Antarctic Mysticetæ; but I have not seen the grounds on which he based his opinion. Practical whalers are of opinion the Mysticetæ killed in the Southern Hemisphere, are identical with those of Davis' Straits and Greenland, only differing in size, arising from the nature of the food.†

Since arriving in New Zealand, I have come to the conclusion that there are at least two species of the Mysticetæ, from an examination of the baleen; that of the Southern Hemisphere being proportionately finer in texture, narrower, and thinner in the blade. Baleen has been used for a great variety of purposes, and, at one time, its value was regulated by the length of the blade, everything under six feet brought a much less price than that of greater length. Now, the baleen in the Arctic whale (central blades of the series) has frequently reached seventeen and eighteen feet in length, whereas the baleen brought from the Antarctic or South Sea, seldom exceeds nine feet. I, at one time, from observing transverse ridges on the sides of the baleen plates, thought that these ridges indicated a periodical interruption in the growth, similar to those observed on the horn of the ox, but from the examination of the baleen belonging to the cranium presented to the Museum by Sir George Grey, I very much doubt the soundness of this theory. The baleen is strictly analogous to the hair, nails, hoofs, etc., and being liable to be worn down, continues throughout the whole life of the animal to grow. A fine and similar example of this wonderful provision of nature may be observed in the molar teeth of the elephant.

* Value of two Whales.—Oil, 20 tons, at £50 a ton, £1,000; Baleen, 1½ tons, at £700, £1,050. Total, £2,050.—*Voyage of the "Diana," whaler, from Hull, in the year* 1866-7.

† The principal whaler has no idea of size in any animal constituting a generic or specific character.

Fig. 1.

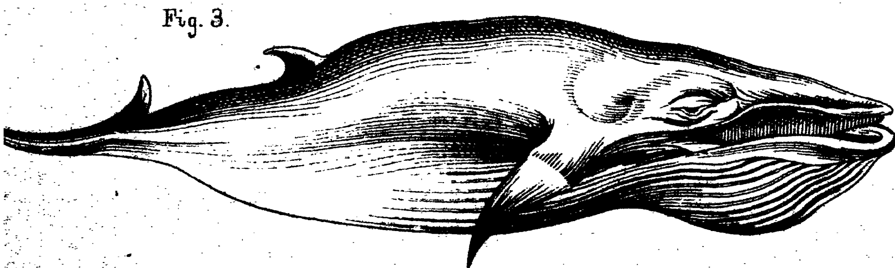


RORQUALUS MAJOR.
Greater Rorqual.

Fig. 2.

Pelvic bones enlarged.

Fig. 3.



RORQUALUS MINOR.
Lesser Rorqual.

TO ACCOMPANY PAPER BY
F. J. Knox.

2. Rorqualus major, Hump-back.

In the autumn of 1831, a whale of unusual dimensions was observed moving about in the Firth of Forth, and was ultimately stranded near North Berwick, within about twenty-five miles of Edinburgh. I was requested by my brother, Professor Knox, to visit the locality, and endeavour to purchase the animal. This I accomplished, after much trouble, and no small cost; the comparative anatomy was ascertained; the most interesting parts, such as sections of the baleen matrix, the arch of the aorta, plaster casts of the brain, etc., together with the baleen *in situ*, were exhibited in the Royal Institution for some time, and were ultimately handed over to the Town Council of Edinburgh. As the skeleton occupied a space of one hundred and twenty feet by forty-five, it was expensive even to afford it house room, and therefore it was put up at the Zoological Gardens.

As an assistance to collectors in New Zealand, I am able to give a careful drawing of the skeleton of this whale. (Plate 2a, Fig. 1.)

The specimen exhibited the characteristic plicæ or folds of the integuments on the abdominal surface. Immediately above the generative organ (male) there was the *hunch* or hump, so diminutive in size, as to require to be looked for. It is worthy of remark that a similar hump is observed on the Cachalot, and that the Rorqual and Cachalot should equal each other in size, in habits, and even in the oil, that of the Hunch-back Rorqual being quite equal to sperm, and indeed containing the spermaceti about the head in considerable quantities. The action of both the Rorqual and Cachalot, upon being attacked, have also a strong resemblance; they retaliate, or as the practical whaler expresses it, "run upon the harpoon or lance," and consequently endanger the boat and crew.

The following measurements were made of the fresh specimen:—

Snout to tip of tail	100 feet
Greatest circumference	36 ,,

The following measurements were made of the skeleton:—

Snout to occipital foramen	22 feet
Length of spinal column	67 ,,
Total length of skeleton	89
Length of lower jaw, external surface	24

VERTEBRÆ.

Cervical (all jointed)	7
Dorsal	15
Lumbar and Caudal	43
Total number of vertebræ	65

RIBS.

Sternal	3
A. Sternal	12
The sixth, the longest.	
Pairs	15

Baleen, the longest blade	5 feet
Total weight of the skeleton	28 tons

ascertained by the tollage charged on passing from North Berwick to Edinburgh.

The cranium was of colossal bulk and weight, exceeding in this respect that of the Mysticetæ, at least ten times. To enable me to remove the cranium from the beach at North Berwick, I had it raised on a frame, and made a transverse section in front of the nostrils; and secondly, a longitudinal section of the cranium, thus allowing me to remove the upper jaw with the baleen *in sitû*, and also obtain a cast of the brain.

3. RORQUALUS MINOR, KNOX.

I am enabled to refer to an original drawing of this animal, with which, to me, an interesting history is connected. (See Plate 2a., Fig. 3.) In the month of February, 1834 (whilst engaged in the preparation of the *Rorqualus major*), a notice was placarded and extensively circulated throughout Edinburgh, that a monster had been caught in the Firth of Forth, near Queen's Ferry, and was exhibited. I formed one of the number of the visitors—although naturally a lover of the "beautiful," and, consequently, disliking the sight of monsters. Notwithstanding that great efforts had been made to disfigure it, I recognized a specimen of the Balænidæ, I made the purchase, and within a few hours there were grouped around the interesting stranger, such men as the late Professor Edward Forbes, Professor John Goodsir, Sir W. Ferguson, and Sir Geo. Ballingall, and it was determined to have a drawing of the specimen. It was suggested that by suspending it horizontally, as in swimming, a much more accurate likeness would be obtained. This was accordingly forthwith accomplished, and Forbes undertook to be draughtsman. The effort resulted in realizing more than our most sanguine expectations. The specimen was evidently that of a young animal, but having obtained the magnificent likeness, it immediately occupied the attention of the practical anatomist, and nearly every part was preserved. The preparation of the skeleton was a work of much labour (notwithstanding its comparative small size) more especially in preserving the baleen *in sitû*. All, however, was ultimately accomplished, and the entire comparative anatomy was presented to the Museum of the University of Edinburgh.

The following notes were made of the recent specimen and skeleton:—

Weight	500 lbs.
Snout to tip of tail	13 feet
Greatest circumference	8ft. 6in

SKELETON.

	ft.	in.
Snout to occipital foramen	2	6
Length of spinal column	7	6
Total length of skeleton	10	0

VERTEBRÆ.

Cervical	7
Dorsal	11
Lumbar and Caudal	30
Total number	48

RIBS.

Sternal	3
A. Sternal	8
Pairs	11

Rorqualus (Sp.,) Trigger-fin, Razor-back, Sulphur-bottom (to be distinguished from the Finner, which is properly the *B. Marginata.*)

The fin which in this species of the Balænidæ is placed in the usual situation, immediately above the generative organs, is said to average from thirty to fifty-five feet in length. The baleen is short; and the blubber in comparatively small quantity. The whales of this species resemble the great Rorqual in their general habits, and, although numerous, do not form a tempting object of capture for the practical whaler. They are common in the neighbourhood of the New Zealand group of islands.

Two young specimens were caught and stranded in Porirua Harbour, in 1867, neither of which I was able to preserve; only taking the measurements as detailed in the annexed tables. The dorsal surface was of a jetty and glossy black, becoming of a light-grey on the abdomen. The characteristic plicæ or folds were well-developed; the longest baleen blade was two inches, of a pale yellow or cream colour. The osteology and comparative anatomy of this whale were not ascertained.

A young female specimen, weighed . . . . 300 lbs.

It measured as follows :—

	ft.	in.	lines.
Snout to tip of tail	9	10	0
Greatest circumference	6	8	0
Snout to nostrils	1	6	6
„ to centre of eye	1	6	0
„ to dorsal fin	5	2	0
Baleen, pale rose colour, longest blade .	0	2	0

General Observations on the Balænidæ.

The entire form of the animals so nearly resembles a fish, as to lead the naturalist, and practical whaler, to insist that the Cetaceæ are fishes; nothing but the researches of the anatomist could have rescued the whale from that class.

The exhibition of the great Rorqual, at the Royal Institution, in 1835, was considered by the great mass of the visitors, as a sheer imposition. They wished to see the skin stuffed. The baleen (in that case *in sitû*) was disbelieved to be a reality by most persons who visited the exhibition. One or two persons actually demanded a return of the admission fee. Yet to the anatomist, the contemplation of the spinal column (trunk) composed of sixty-five vertebræ (out of many of which the entire skeleton of the ox could have been fashioned), and these connected by sixty-five joints, many of them containing a gallon of joint-oil, presented a lever, or rather a whip-shaft, to the tail, which left no doubt of the effects of the application of its distal extremity to a whale-boat.

I remember a whaler of the name of Thoms, residing on the Island of Kapiti, who was merely touched by the tail of a Mysticete, and nearly every bone on one side of the body was broken. Fortunately, there was no "duly qualified doctor" to be had, and Thoms consequently got quite well, with the exception of a slight lameness. When brought to the station, he was lifted out of the boat with considerable difficulty, being literally glued to the boat by the blood lost.

The sternum, also, is remarkably short, having only two or three pairs of ribs connected to it. Now, this, instead of indicating a rudimentary condition, rather proved the Divine perfection in all nature's works. In consequence of the smallness of the sternum, the great respiratory muscle—the diaphragm—measured in the great Rorqual, 60 feet in length, by an

average breadth of 10 or 12 feet; thus enormously increasing the capacity of the chest at the will of the animal, either thereby depressing the locomotive power, or increasing it when determined on a rapid journey.

It has been demonstrated by the comparative anatomist, that the Mysticetæ, and, in all probability, the Rorquals, at an early period of uterine development, have numerous cone-shaped teeth, unfilled, for their future existence. These teeth, accordingly, never proceed beyond the first stage of development, and the young cub at birth, is a sucker. The palate, soon after birth, becomes covered with numerous transverse ridges, and a white horny substance begins to spring from them, lengthening with the growth of the animal, and corresponding to the development of the jaws, longest where the arch of the upper jaw is greatest, and diminishing towards the throat and snout, to mere hairs. Thus, the animal destroys myriads of minute mollusca, and even microscopic marine insects, which, from their enormous increase, might become the source of pestilence, had it not been for their wholesale consumer.

Notes by Dr. Hector.

The following is a list, with dimensions, of those specimens of Cetacians in the Colonial Museum, Wellington, which possess interest from their being rarely represented in collections.

1. Balæna Marginata (Gray).

Cranium presented by Sir George Grey: obtained at the Island of Kawau—See Plate 2b, Fig. 1, upper surface; Fig. 2, lower surface; Fig. 3, side view; Fig. 4, section showing Baleen *in sitû*.

Weight of cranium	58 lbs.
,, of lower jaw	13 ,,
Total weight	71 lbs.

Measurements.

	ft.	in.
Snout to occipital foramen	4	9
,, to fronto-nasal suture	2	10
,, to centre of orbit	3	10
Breadth at nostrils	2	5
,, mastoid processes	2	7
Lower jaw—length; convex surface	3	11
,, greatest depth	0	8

Baleen, 29 inches long, $3\frac{1}{2}$ inches wide.

From the character afforded by the baleen of this specimen, I conclude that it is the head of the *Balæna Marginata* (Gray), or West Australian whale.

Dr. Gray says*:—"This species is only known from three laminæ of baleen. It is much smaller and broader, compared with its width at the base, than, and is differently coloured from, the baleen of any of the other species.

"The baleen very long, slender (nearly eight times as long as wide at the base), pure white, thin, with a rather broad black edge on the outer straight side.

"This is, undoubtedly a very distinct species. The baleen is of nearly the same structure as that of the Greenland whale; but we do not know

* See "Catalogue of Seals and Whales in the British Museum," p. 90.

Fig. 1.

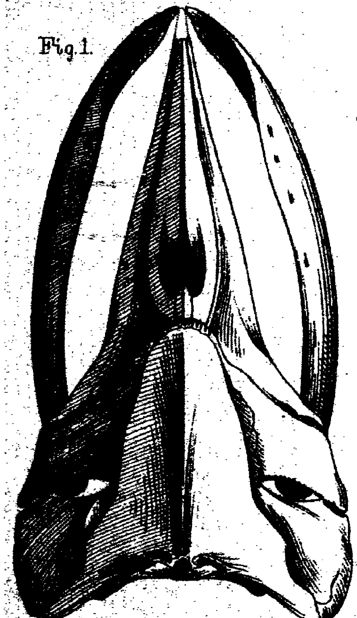


Fig. 2.

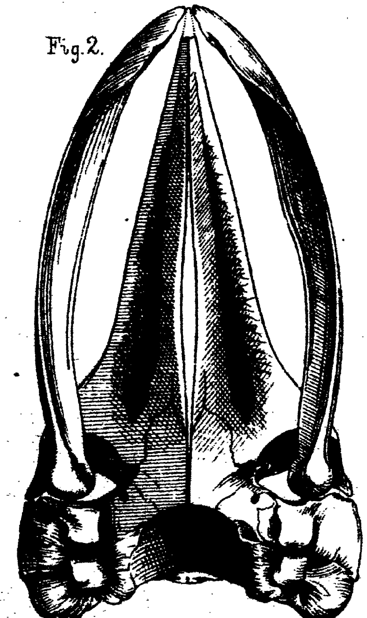
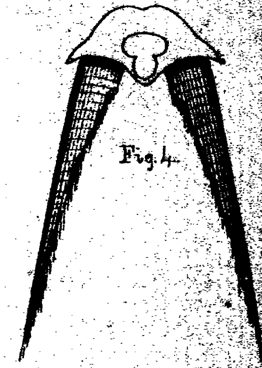


Fig. 3.

Fig. 4.



Section of skull with baleen in situ.

Fig. 5.

Profile view of skull of Mysticete.

SKULL OF BALÆNA MARGINATA GRAY ZOOL. E & T.

Captured at Kawau Island

Pres. to Col. Mus. by Sir George Grey K.C.B.

what may be the form of the first ribs, or of the bones of the other parts of the skeleton."

The plates of baleen, in the Kawau specimen, presented by Sir George Grey, are slightly longer than the dimensions given above, but the proportion of width to length is the same; and the well-marked black margin $\frac{1}{4}$ to $\frac{3}{8}$ of an inch in width, clearly identifies the species.

This interesting specimen, must therefore, be considered as unique, and has been carefully figured in Plate 2b.

2. Berardius Arnuxii (Duvernoy).

Skull and lower jaw, cervical vertebræ, scapulæ, hyoid, pectoral extremities right and left, and pelvic bones of one individual; also, a single tooth of another individual, weight, 206 grains.

Length of head	23·5 inches
„ nose	15
„ dental groove	7
„ lower jaw	19
Width, notch	5·5
„ orbits	9·5
„ intermaxillary at blow holes	4·5
„ nose	2
Height at occiput	9·5

One small tooth imbedded close to tip of lower jaw on left side, one inch high; weight, 38·8 grains; irregular triangular shape. This is the skull of a young animal. A strong ligament connecting the muscle of the forehead with the snout is deeply imbedded in the intermaxillary groove. The snout is described as long and flexible. Atlas and axis anchylosed.

Length of cervical vertebræ, 3·7 inches. Scapula, longitudinal diameter, 10 inches; transverse diameter, 6 inches. Pectoral extremities, length, 14 inches; width, $3\frac{1}{2}$ inches. Hyoid arch, 55 by 4 inches high. Pelvic bones, $2\frac{1}{2}$ inches.

The specimen was cast on the beach of the West Coast, near Porirua Harbour, and was prepared by Dr. Knox.

Only two other specimens have, hitherto, been obtained; the first at Akaroa in 1846, now deposited in the Paris Museum; the second was captured at the mouth of the Avon, and prepared by Dr. Haast, for the Canterbury Museum (see Art. 45, p. 190).

A fourth, and very large specimen, has been lately stranded in Wellington Harbour, and, in part, secured for the Museum by Dr. Knox, who, from his examination, has some doubt of the identity of the above species, founded on the character of the teeth.

3. Lagenorhyncus Clanculus. Complete Skeleton.

	ft.	in.
Total length	5	1
Cervicals (7) anchylosed		1·3
Dorsals (14)		11·5

Lumbar and Caudal 48, thirty-four of which have processes, and may be considered as lumbars.

SKULL.

	inches.
Length—total	14
„ beak	7·5

SKULL,—*continued.*	inches.
Width at notch	3·5
„ at orbit	6
„ of intermaxillary at blow-hole	2·7
„ at middle of beak	2·5
Height of occiput	5·7
Length of flappers	12
Scapula, longitudinal	6·5
„ transverse	4·5

This specimen was harpooned outside Wellington Harbour, and appears to be the common Dolphin of the Coast.

Lower jaws of two others.
Three skulls of *Delphinus sp. (?)*.

4. GLOBIOCEPHALUS MACRORHYNCHUS. (Gray.)

Black-fish of South Seas. Two skulls, one showing longitudinal section.
One lower jaw, six cervical vertebræ.
Four lumbar, thirteen caudal, two scapulæ.
Two hyoids.

Both skulls are of the same dimensions.

	inches.
Length	26
„ of nose	15
„ of tooth series	8
„ of a lower jaw of a different individual	15
Width at notch	11
„ at orbit	17
„ of intermaxillary at blow-hole	7·5
„ at middle of nose	9·5
Height at occiput	14
Scapula, transverse diameter	15
„ longitudinal diameter	12

Hyoid arch, 11 inches wide, by 7 inches high: Sternum, 10 × 7 inches, with three sternal ribs, each 7 inches long.

First rib is 10 inches from head to tip, but is bent, with an arch of 5 inches.

Atlas, axis, and three other cervicals are anchylosed. The combined cervicals have a conjoined length of four inches.

Vertical diameter of Foramen magnum, 2½ inches; conjoined length of the four Lumbars, 8 inches; height, including spinous processes, 8·5 inches; caudal appendage, 16 inches, of thirteen segments, two of which are anchylosed; teeth, $\frac{9\cdot9}{8\cdot8}$

This species is only known from two imperfect specimens in the British Museum and College of Surgeons' Museum.

ART. V.—*On Seals of the genus* STENORHYNCUS, *captured on the East Coast of Otago.** By J. S. WEBB.

[*Read before the Wellington Philosophical Society, August* 14, 1869.]

IN August, of last year, a very handsome seal was discovered on the Green Island beach, about a dozen miles to the southward of Otago Heads. It was

* The seals, referred to in this paper, have, since it was written, been determined by Dr. Hector as specimens of *S. Leptonyx*. The descriptions of *S. Leptonyx*, accessible to the writer, were all transcripts of that given by M. F. Cuvier, from the first specimen

captured without much difficulty, and was purchased, and presented to the Museum, by Captain Fraser. This specimen proved to be a female. Shortly afterwards, a male of the same species was caught in our harbour, and was also secured for the Museum. These seals are of a species by no means common on any part of the coast of New Zealand. They belong to the genus *Stenorhyncus* of M. François Cuvier, a form restricted, so far as we know, to the Southern World. In the Museum they are labelled as *S. Weddellii*, the *Phoca Leopardina*, of Jameson, or Leopard Seal. The skins have, as I can vouch, been carefully stuffed by the Curator of the Museum, and I have secured for that Institution such portions of both skeletons as were not retained in the stuffed specimens. I am able to forward, for the use of the Society, good photographs of these seals, which Mr. Alfred Burton was kind enough to take for me, for this purpose.

The inappropriateness of the name Leopard Seal, cannot but strike any one on examining these specimens. This has led me to look up such information, as is procurable here, about the genus to which they belong, and I have been obliged to conclude that these seals are not the same as *Weddellii*, and that they remain up to the present time undescribed in works of Natural History. At the risk, therefore, of repeating what some one may have done before, I venture to send the following description of them to the Society, since, no doubt, the majority of naturalists in New Zealand have as little opportunity as myself of referring to any description that may have been published at home during the last few years.

The genus *Stenorhyncus* was first defined by M. Fr. Cuvier, and is most readily distinguished by the very peculiar character of the teeth. Of these "the molars are deeply divided into three long points, which are conical, and somewhat hooked," the central process in each being considerably longer than the others. Compared with the typical *Phoca*, the narrowness, and comparative length of the snout, is very noticeable, and it is on account of this feature that the generic name *Stenorhyncus* (narrow-muzzle) has been given. Only two species have hitherto been described, both found in the southern hemisphere. *S. Leptonyx* (the Small-nailed Seal of Cuvier) has been taken in South Georgia, and the Falkland Isles. *S. Weddellii* (Leopard Seal of Weddell) appears to come from localities still further to the South, in the same region of the globe. Captain Weddell, in his "Voyage towards the South Pole," speaks of its occurrence at the South Orkneys, and on the mainland of South Shetland. Of this species, a specimen in the Edinburgh Museum is the only one recorded as having reached Europe. It has been figured and described in the "Naturalist's Library," in a monograph on the Amphibious Carnivora, which forms the twenty-fifth volume of that collection. It is from the comparison of this drawing, and Captain Weddell's description of his Leopard Seal, with the seals captured here, that I have concluded that the latter belong to a new species. The shape of the head is, I think, conclusive on this point; our New Zealand seals being by no means so typically narrow-muzzled as the Leopard Seal. The following table of measurements (attached) shows very clearly the divided differences between *Weddellii*, and the species which I presume to be new to science. Whilst the length of the Edinburgh specimen is nearly one-half greater than that of the largest of ours, and its greatest girth almost double,

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brought to Europe, and did not lead to the idea that the seals, in question, could belong to that species. There is reason to believe that the measurements of the head of Weddellii, given by Dr. Hamilton, from the stuffed specimen in the Edinburgh Museum, under-rate its width. In the seals caught here, the mass of fat, etc., between the skin of the head, and the skull, was very considerable.—J.S.W.

The skeleton of a specimen of this seal, captured in Wellington Harbour, in 1840, was sent to England, accompanied by full anatomical notes by Dr. F. Knox.—*Catalogue of Whales and Seals in the British Museum.* J. E. GRAY, F.R.S., page 16.—ED.

the distance between the inner angles of the eyes is one-half greater in the New Zealand seal, than in *Weddellii*, and the circumference at the upper part of the neck about the same. The distance from the angle of the mouth to the tip of the lower jaw, is also much greater in our specimens, than in the other. Whatever hesitation we may have in relying on the measurements taken from a stuffed specimen, those about the head and jaws are not likely to be inaccurate. In this case, they show that the New Zealand seal is much longer in the jaw, and generally broader in the muzzle than that from South Shetland. It will be noticed that the fore-paw is proportionately larger. This, and the posterior extremity, differ much in shape from those of *Weddellii*, the toes being connected throughout by membrane. They are, respectively, extremely like the fin and tail of a fish, whilst those of the Leopard Seal are very similar to the limbs of a true *Phoca*. The presence of nails on the posterior extremity, is also a distinguishing mark.

The general differences of appearance are also very noticeable, although, as all seals seem to vary much in colour and markings, at different ages, I should not have ventured to think them specific, in the absence of more important ones. Captain Weddell has given but a meagre description of the Leopard Seal, speaking of it as if it were already known. He gives the colours as "pale-greyish above, yellowish beneath, the back spotted with pale white," an expression which probably means "dull white." The plate in the "Naturalist's Library" (in which, by the way, the colouring has evidently been taken by the artist, not from Weddell's description, but from the highly discoloured Museum specimen), shows large oval spots, all nearly even in size, and pretty uniformly distributed. The seals, I am describing, are of a slatey grey, above, a medium shade, the female being a little lighter coloured than the male. The spots are both white and black, the latter being most numerous; none, strictly speaking, on the back, whilst those on the upper part of the sides are small, and distributed very differently from those on the Leopard Seal. The spots and markings will be best understood by a reference to the photographs. Though the grey on the back has come out very dark in these, the black spots remain distinguishable. It is proper to mention, also, that all the whites appear as much too bright in the photographs, as the greys are too dark. An accurate idea of the colouring cannot be had from them. The large patches of black on the under parts of the male, are probably only signs of youth, as in the Fur Seal. The black is pure in the male, nearly so in the female. There was no trace of a yellow tinge on the under portion of the body when the animals were alive, though there are now some slight signs of that discolouration to which all stuffed specimens of seals are subject, from the impossibility of entirely freeing the skin from oily matter. The general colour beneath, when the seals were newly killed, and wet, may be described as that of sea ice, a dull white, with faint bluish-grey tinge. I append more particular descriptions of each specimen, sufficient, I think, when taken in conjunction with the measurements, to enable any one to identify the species in case of future capture.

I am informed (at second hand) from several quarters, that, though very rare on the New Zealand coast, these seals are common at the Auckland Islands, where they have been seen from sixteen to twenty feet long.

Statements made by the Maoris to Mr. Beverly, when he accompanied Dr. Hector on an expedition to the West Coast of this Province, agree with these reports as to the large size attained by these seals. The Maoris speak of them as much larger than the *Wigs*, as they call the full-grown Brown Seal of our coasts. One of the latter was killed during the expedition referred to, which weighed 3 cwt., but I have not been able to ascertain its dimensions. I hope this notice may lead to further information on the subject being made

known. There must be many persons in New Zealand who have had opportunities of seeing these seals alive.

With regard to the time at which the seals made their appearance here, I may remark, that Captain Weddell, when describing the habits of the Fur Seal, says, that herds of small young seals come on shore in August, for about five or six weeks, and then retire to the water. Of the habits of the Leopard Seal, he has not given any account. The seals caught here are young ones, if I may judge by their size, as compared with that of others described by visitors to the Auckland Islands. Mr. Arthur Beverly, who examined them immediately after their capture, is of opinion that the female had never been pregnant. The time of parturition amongst seals of the southern seas appears to vary considerably. With the Fur Seal, it is in November and December, and the animal is not adult until nearly two years old. Probably this may be about the age of the specimens under consideration.

I shall add, that there is a skin of a *Stenorhyncus*, which appears to be of the same species as that I am describing, in possession of the Dunedin Athenæum. It was lying in the Government Offices here, for many years, before it was handed over to its present custodians. It is imperfect, and very roughly stuffed, and is now of an almost uniform dingy brown. Markings may, however, be traced on the belly, similar to those on the female specimen in the Museum. I have included in the appended table such measurements of this seal as could be fairly depended upon, as representing something like the original size. These, it will be seen, correspond, pretty well, with those of the seals in the Museum. The specimen is smaller, but the teeth are perfect, and I have no doubt that the skin is that of an adult.

In conclusion, I may express the hope that the partial revival of whaling enterprise in this part of the world, may enable us to add something to the scanty store of facts, hitherto published, in regard to the seals, and other living forms, of the Southern Seas. Except in the case of the Fur Seal, very little indeed, is known about any of the seals that frequent Antarctic shores. No doubt there are many new species to be discovered, and with regard to their habits, and economy, the field is all but untouched.

Should the opinion I have expressed, as to these seals being hitherto undescribed, prove correct, perhaps I may be allowed to claim the usual privilege, and suggest a specific name; *Crassicollus* will recall the feature which most readily distingushes this seal from others of the genus, and will not excruciate the ears of a scholar, more than the majority of scientific names must do.

DESCRIPTION OF SEALS CAUGHT NEAR DUNEDIN, NEW ZEALAND, AUGUST, 1868.

Stenorhyncus, ———?—Male.

(For measurements of both specimens see table annexed.)

Head proportionately larger than the *Weddellii*, and neck less tapering. Body largest immediately before the fore-arm, tapering very gradually to the base of the posterior extremities. Fore paw very fin-like, first finger (or thumb) much the largest; fingers united by membrane, which extends from half an inch to an inch beyond the nails; nails black, not sharp, or much curved, about half an inch long. Hind paws furnished with membrane to the extremities of the toes, making the paw, when expanded, look very like the symmetrical tails of the pilchard, and some other *Clupeadæ;* nails well developed on three middle toes, less so on the others, brownish-black, tipped with yellowish-white. The external aperture of the ear is easily distinguishable. The ear-tube was found fine as a medium sized pin (about the No. 19 trade-gauge of wire). Hair soft, and moderately thick-set, a medium shade of slatey-grey on the upper half of the body, dull-white below. The dividing line between these colours is rather

distinctly marked, passing from the nostrils immediately under the eye, and dividing the surface of the body into nearly equal parts throughout. (In the photograph the head of the male shows wholly dark, from some accidental circumstance). The upper part of the head is slightly darker than the back. Numerous spots and patches of black, especially on the hinder part of the belly, where the black becomes predominant; small white spots are also intermingled with the black ones, especially over the hind ribs. Some of the smaller spots are grey.

Female.

Considerably larger than the male, but proportionately shorter in the neck, which is also thicker, giving a marked difference of figure to the fore-part of the animal. External aperture of the ear distinguishable, but not so readily as in the male. Colour rather lighter than in the male, with very few traces of the black patches, so prevalent on the lower part of the body of the latter.

In both *male and female* the teeth are perfect: and the dentition normal, $\frac{2 \cdot 1 \cdot 5}{2 \cdot 1 \cdot 5} = 32$. The description given by Dr. Hamilton of the teeth of the *Weddellii*, answers exactly for those of these seals, and I, therefore, copy it: "The incisors are conical in their form, and somewhat curved inwards; those "in the upper jaw are by much the longest, and the two middle ones are "placed further within the mouth than the other two, and are also much "smaller" (this latter peculiarity is shared by those of the lower jaw); "the "canines are conical, very much developed at the base, and slightly grooved; "the body of the molars is composed of three parts, the central conical part by "much the longest and largest, with a small tubercle on each side."

TABLE OF MEASUREMENTS.

	S. Weddellii.	Specimens in the Otago Museum.		Specimens in the Dunedin Athenæum
	Sex unknown.	Male.	Female.	Sex unknown.
	ft. in. lns.	ft. in. lns.	ft. in. lns.	ft. in. lns.
1. Total length (over the back) from tip of snout to tip of tail	9 10 0	5 11 8	7 1 6	4 10 6
2. Length of tail	0 2 6	0 3 0	0 3 6	0 2 0
3. From snout to anterior edge of the base of the fore paw	3 5 0	2 5 0	2 3 6	1 9 8
4. From base of posterior margin of fore paw to tip of tail	6 4 0	3 2 6	4 5 9	3 0 0
5. From base of one fore paw to base of another, across the back	3 1 0	1 8 5	1 8 0	1 8 2
5. Circumference, greatest round body	6 4 0	3 6 0	3 6 11	2 9 11
7. Ditto at upper part of neck	1 11 0	1 10 10	2 3 7	1 5 10
8. Ditto above the tail ...	2 3 0	1 10 8	2 0 0	1 5 6
9. Length of fore paw round anterior margin	1 1 0	1 1 9	1 3 8	Damaged
10. Length round posterior margin ...	0 8 0	0 9 8	1 0 3	Ditto
11. Greatest breadth of forepaw ...	0 4 10	0 4 6	0 5 6	Ditto
12. Ditto length of posterior extremity	1 5 6	1 1 0	1 3 0	0 10 6
13. Ditto breadth, toes being extended	1 4 0	1 2 5	1 2 10	not ascertainable.
14. Breadth at base of the foot	0 4 6	0 4 3	0 4 7	Ditto
15. Distance between inner angles of eyes	0 3 6	0 5 6	0 6 2	0 3 6 Doubtful
16. Ditto angle of mouth and tip of lower jaw	0 4 0	0 5 5	0 5 9	0 5 3

NOTE.—In Nos. 5 and 12, it is uncertain whether my measurements correspond with Dr. Hamilton's as to the points chosen to measure from. I take No. 12 from angle between tail and flipper.

ART. VI.—*On a (probably new) variety of the Small-nailed Seal,*—STENORHYNCUS LEPTONYX, *of Cuvier, and De Blainville, and allied to the* PHOCA LEOPARDINA, *of Jameson.* By the REV. CHARLES FRASER, M.A., F.G.S.

(Read before the Philosophical Society of Canterbury, December 2, 1868.)

EARLY in the month of August, 1868, a Seal was caught in the harbour of Lyttelton, and afterwards was exhibited in Christchurch, which seemed to present some characteristics worthy of notice, and which, indeed, seems to differ from any of the varieties hitherto described.

It measured over eleven feet eight inches in entire length, and six feet in girth at the stoutest part. From the decayed state of some of the teeth—the two under-canines being broken off near the gum, and one having a hole three-fourths of an inch deep—the animal must have been full-grown, and even aged. The upper canines projected fully an inch and a half from the level of the gum. Teeth, incisors, $\frac{4}{4}$; canines, $\frac{1-1}{1-1}$; molars, $\frac{5-5}{5-5}$. The dentition, and the very marked tricuspid appearance of the molars, proved its identity with the genus *Stenorhyncus.*

There was no external ear. Bristles only on the upper lip. No soft, upstanding, furry hair, as in the *Stenorhyncus Weddellii*, or Sea Leopard, but only the thin, sparse, longish hairs, lying close to the skin, and distributed over the whole body. The swimming paws much resemble those of the *Macrorhinus*, or Sea Elephant, having more the shape of a fin, or wing, than of a paw. The nails are small upon the fore-paws, and very small, but still present, upon the hinder extremities. These last were scarcely, if at all, lobed, and more resembled fish-tails.

In colour, the animal was grey above, with black flakes, and a brownish tinge, all over the central part of the upper surface. On the sides, the black spots were replaced by white flakes; while the under part of the body was light grey. The fore-paws were white, with light grey flakes. The hinder extremities were black, with light grey spots.

There was no tail, nor even the rudiment of one. The vertebral column terminated, in a round compressed manner, under the skin, which extended about three inches beyond it, so as to form the curve which united the two hinder extremities.

The anal aperture was quite distinct from the urethro sexual canal, as if there were no common cloacal sphincter muscle; this appearance may, however, have been partly owing to the relaxed state of the animal's flesh, it having been dead for some time, and partly to the great pressure of the body upon the lower surface.

The weight of the animal was said, by the capturer and exhibitor, to be about 1,200lbs.; it was, probably, a little over half that figure.

I had an opportunity of afterwards examining a Sea Leopard (*Stenorhyncus Weddellii*), and comparing it with the above description. But this second individual exactly suited the ordinary account of the animal as I have named it. It possessed a covering of fur on the upper part of the body, and a tail about three inches long, and was decidedly smaller in size.

In attempting to define the place of the seal, described above, it may be sufficient to refer to the number and kind of the teeth. Of the eight genera, into which seals are now distributed, two possess the same number of teeth,—thirty two,—viz., *Stenorhyncus* and *Pelagius*, but the under molar teeth of the latter are not tricuspidated, and the upper molars are but slightly notched.

Confining our attention to the two species of the *Stenorhyncus*, the *Leptonyx*, or Small-nailed, and the Sea Leopard, we find the character of the former, which notes the presence of the small nails both in the hinder and

former extremities, decides the place of this animal. But when we take into account the colours of the flakes which spot its whole body, the very slight indentation of the lobes of the hinder extremities, and the entire absence of a tail, it seems as if it had claims to be regarded as an entirely new species.

Art. VII.—*On a species of* Ophisurus, *found on the Coast of New Zealand.* By James Hector, M.D., F.R.S. *With anatomical observations, by* F. J. Knox, L.R.C.S.E.

(With Illustrations.)

[*Read before the Wellington Philosophical Society, August* 14, 1869.]

The genus *Ophisurus* includes a section of the Eel family, which has not been previously recognized as represented by any fish on the New Zealand coast. The only eels mentioned in the lists of New Zealand fishes, are two fresh water species, *Anguilla Australis* (also found in Australia), and *Anguilla Dieffenbachii*, which Richardson considers as only a variety of the former, and a Conger Eel (*Congus habenatus*), which is found in Cook's Strait, and on other parts of the coast.

In Richardson's work "On the Antarctic Fishes," he describes twenty-five species of Ophisurus, but they all appear to have been obtained from tropical seas, and none of them present the same characters as the fish which I have to describe.

The specimen was received, with the following memoranda, from Mr. Atkinson, R.M.—"*Puni Horua*, caught in a tidal creek, near Makaraka, Poverty Bay, June 24, 1869."

The form and colour of the specimen has been considerably altered by the spirit in which it had been preserved, but it presents the distinctive characteristics of the Ophisurus, or Snake-Eels, having the slender, compressed head, and slightly expanded snout, and the tail prolonged to a naked point, beyond the dorsal and anal fins. Its colour is dark chesnut-brown, with a silvery lustre beneath. The nasal disk is bordered by six acute subulate teeth, and on the mesial line, two minute teeth, and one stout acute tooth. Behind this, the vomerine teeth form a single row in the mesial line, commencing with two stout teeth, and continued by twelve minute, recurved, subulate teeth. Palatine teeth are uniserial, consisting of thirty-four minute teeth, with recurved tips, extending from the nasal disk to the angle of the mouth. The mandibular teeth are uniserial, and correspond, in number and form, to those on the nasal disk, and palatines. The eyes are placed in the middle of the gape, about half the diameter of the orbit below the top of the head. The gill openings are large, and placed in front of the pectoral fin, which is small and acute. The dorsal commences over the pectorals, and lies in a groove extending to within half an inch of the tip of the tail; its greatest height being three lines. The anal extends to within three lines of the tip of the tail, and is four lines wide, immediately behind the anus. The total length of the fish is thirty-four inches; tip of nose to anus, thirteen inches; to gill openings, two inches six lines; length of gape, one inch four lines. The nearest species described by Richardson is *O. Rostellatus*,* from Senegal, but it presents marked differences in the dentition, having a different number of teeth, which are biserial; and in the pectoral fins, which, in *O. Rostellatus*, are large and oval. The proportions are also slightly different. I therefore propose to distinguish this fish as a new species, and call it *Ophisurus Novæ Zelandiæ*.

* Richardson's "Antarctic Fishes," p. 105

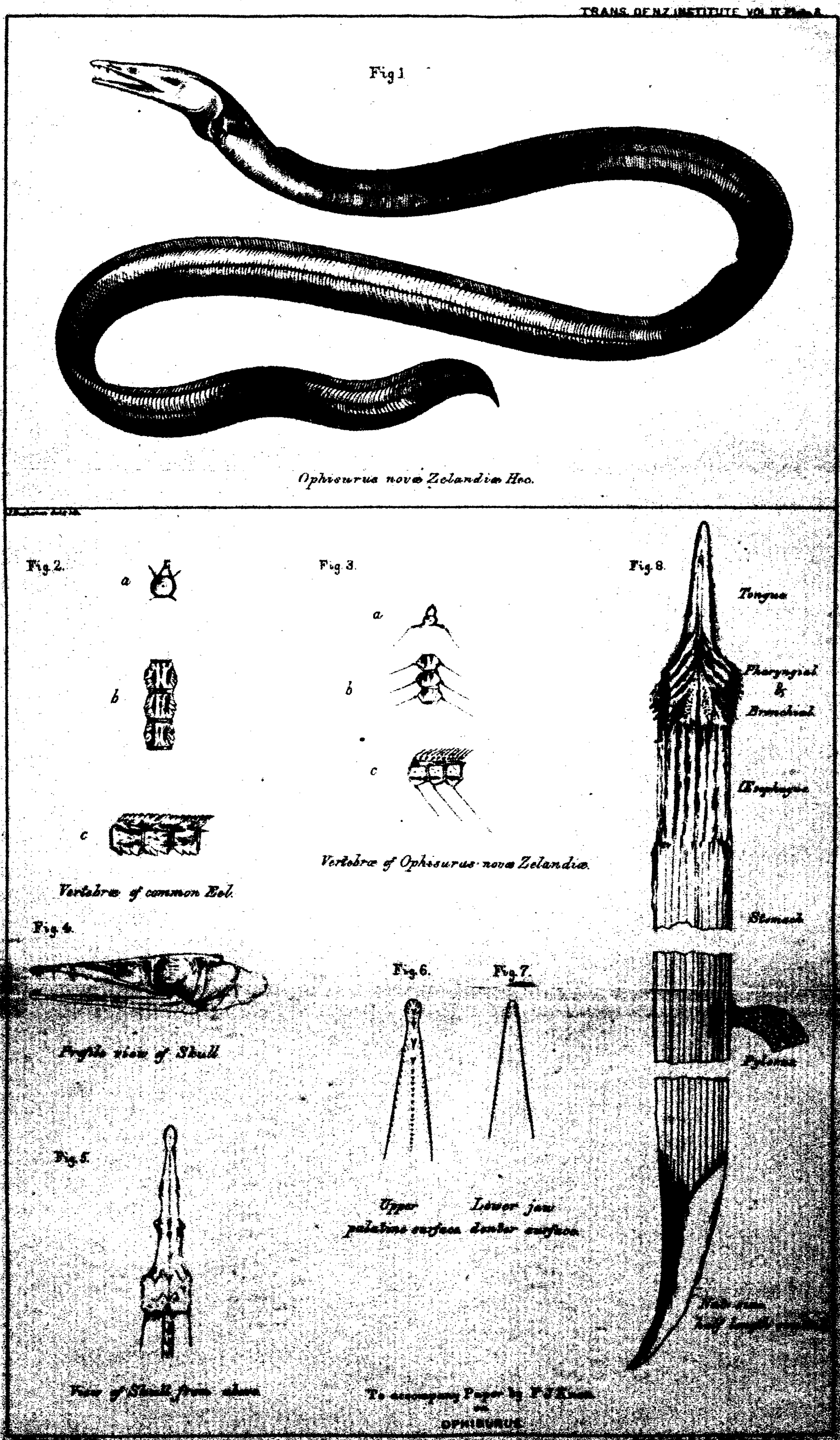
Fig 1
Ophisurus novæ Zelandiæ Hec.
Fig. 2.
a
b
c
Vertebræ of common Eel.
Fig. 3.
a
b
c
Vertebræ of Ophisurus novæ Zelandiæ.
Fig. 8.
Tongue
Pharyngial
&
Branchial
Œsophagus
Stomach
Pylorus
Fig. 4.
Profile view of Skull
Fig. 6.
Fig. 7.
Upper
palatine surface
Lower jaw
dental surface
Fig. 5.
View of Skull from above
To accompany Paper by F. J. Knox
on
OPHISURUS

Dr. Knox having undertaken the dissection, and minute anatomical description of the specimen, has furnished the following valuable notes; together with the preparations they refer to, which are deposited in the Colonial Museum.

Anatomical Observations on Ophisurus Novæ Zelandiæ, (Hector.) By Dr. Knox.

The Integuments.

The external characters of this fish having been given by Dr. Hector, I shall only make a few remarks on the skin. The specimen having been preserved in strong alcoholic mixture, necessarily altered, not only the colouring, but also the integumentary tissue itself; not a vestige of scales could be observed, and considerable difficulty was found in removing the skin, more especially at the connection of the dorsal and anal fins. Little or no oil appeared to be present, and when dried, the absence of oil became more striking. I found it, viewed as a transparent object, entirely dotted over with minute black spots; and immediately *below* the lateral line, a regular series of spots of larger size, and placed at about two lines from each other. These latter I consider glandular orifices; they are also very distinct on the lip or margin of the upper and lower jaws. On the inner surface of the abdominal aspect of the skin, there extends, from the gill aperture to the anus, a well-developed cutis-muscle, which, by its contraction, will assist in progression, in a similar manner, to the abdominal scutæ in some of the Reptiliæ (Tuatara, etc.), no doubt required, in consequence of the extremely rudimentary nature of the ribs.

The Skull—Fig. 4.

The head of the Ophisurus is at once remarkable for its smallness, and for its high degree of development. The organs of sense, and the dentition, are fully represented. The Ophisurus stands, in this respect, in strong contrast to fishes, in which the head is almost universally, enormously (disproportionally) developed. Even in his closely-allied relation, the eel (Murœna, Linn.), the head continues to hold something like a proportion to the body. It will be seen from the annexed table of weights, that the total weight of the skull is thirty grains, but this is much beyond the true weight of the bones, as the integumentary covering on the right side, was left *in situ*, in order to display the position of the nostrils, and the gill coverings, and thus the bones in the skeleton of the head would certainly not weigh more than fifteen or twenty grains.

The smallness, added to the non-development of the osseous centres of ossification, render any attempt to describe the separate bones of the skull, impossible. The view of the skull from above (Fig. 5) exhibits, very beautifully, the fact (although not very long ago, the theory) of the head being merely a continuation of specialized vertebræ; it does not signify whether the number be 3, 7, or 7 times 7.

The upper jaw (Fig. 6), after gradually narrowing, expands into a semi-oval surface, convex above, concave on its dentar or buccal aspect. The rami of the lower jaw (Fig. 7) are proportionally long, and quite straight, terminating with a symphysis peculiarly formed, so as to receive an azygos tooth in the upper jaw. The opercula are well developed.

The lower jaw (Fig. 7) is formed of two perfectly straight rami, uniting at the symphysis by cartilage, and articulating with the articular process of the temporal bones in the usual manner; the temporal fossæ are large, affording ample space for the attachment of strong temporal muscles, no doubt occasionally required when an unusually large crawfish is selected for a feed.

Dentition.

The dentition of the Ophisurus differs so entirely from that of the eel, as to remove it from the same class or order of fishes, but it would be a great stretch of classification to place him with the serpent, on account of his peculiar dentition. The teeth are all conical, but vary in size, evidently suited for seizing, killing, and retaining the prey. I conclude that the food will consist of crustaceous insects of considerable size, which will be swallowed entire, to be acted upon by the juices from the inner surface of the capacious stomach. On the alveolar (dentary) margin of the upper jaw, and on the expanded extremity (Fig. 6) there are seven teeth, an azygos tooth, and three on each side, which gradually increase in size as they leave the mesial line; a vacant space corresponding to the contraction of the jaw, above alluded to, is followed by a series of minute teeth. On the mesial line of the jaw, a peculiar arrangement occurs, in a line with the azygos tooth, one a little larger follows, then two minute teeth, then a tooth still larger than the first, followed by an empty space, then a tooth still larger than its predecessors, and then an empty space, then a tooth less than its predecessor, which is followed at a little distance by a smaller one, and a series of minute teeth follow, becoming gradually microscopic. The entire mesial series, above described, are embedded in a groove, occupying the entire length of the base of the skull, and approaching closely to the first vertebra of the spine. The transcendental anatomist would call these teeth vomerine, but I shall continue to look for the vomer, in connection with, and performing its usual function, as dividing the nostrils.

The lower jaw (Fig. 7) supports three teeth on each side, corresponding to those on the upper jaw, and leaving a space at the symphysis for the azygos tooth.

The alveolar (dentary) edge then supports a series of minute teeth of beautiful regularity, resembling a fine saw, or comb.

The tongue is edentulous, but the pharyngeal bones are covered with minute teeth; a series of a slightly increased size, bordering the external margins of these bones. The arrangement, no doubt, when brought together by the action of the pharyngeal muscles, in performing the act of swallowing, subjecting the shrimp to a severe scrutiny, not only touching its quality, but its vitality.

THE VERTEBRAL COLUMN.

In order to facilitate description, and avoid repetition of terms, I propose to describe the Ophisurus as presenting a dorsal and abdominal margin, and right and left lateral surface, as being equally applicable to the skeleton, as to the external surface of the body. The osseous tissue approaches that familiar to the anatomist as the semi-cartilaginous, although each individual vertebra is well defined by a perfectly formed articulation; and the canal for the spinal marrow is composed of a texture more resembling the shell, in hardness, than bone. In viewing a separate vertebra (Fig. 3*a*), the spinal canal will be observed nearly as large as the articular surface of the body of the vertebra, and the proportions still continued throughout the entire spine. A mere rudiment of the spinous process exists, and a fibrous membrane of considerable extent separates the interspinous processes and fins, from the vertebræ. On the abdominal line (Fig. 3*b*) on each side, a plate, or process, extends, and presenting a convex free margin to which is articulated an exceedingly delicate rib, the ribs, indeed, more resemble a fine hair than a bone, and do not admit of drying so as to be seen in the skeleton.

Fig. 3*c* is a lateral view of three of the vertebræ, and exhibits the rudimentary state of the spinous processes, and the fibrous membrane separating

the inter-spinous processes, and corresponding dorsal fin, from any immediate connection with the spinous processes of the skeleton, explaining the almost complete disappearance of the fin, in the recently caught specimen. The abdominal plate or process will be observed to support the ribs, as previously remarked; and it is necessary, particularly, to refer to this fact, as, in describing the caudal division of the spine, it will be again alluded to.

About the eightieth vertebra, the canal for the blood-vessels begins to be formed, and here an additional system of processes is found. The abdominal processes close upon each other, still continuing to support delicate, hair-like, ribs, while a series of cartilaginous processes gradually appear on the lateral surfaces of the bodies of the vertebræ, and continue to the extremity of the spine. There are two of these processes on each side, evidently arising from the vertebræ in the fish being composed of two elementary parts, divided transversely in the middle, like an hour-glass; and the resemblance is rendered perfect by the communication being free, a fine wire passing readily through. The fact of a vertebra being, at an early period of the progressive development of the skeleton, composed of the elements of two vertebræ (and this can scarcely be doubted), would, if the development was arrested, give double the number of vertebræ, or 420 instead of 210.

Had Sir Charles Bell selected, for his Bridgewater Treatise, a vertebra, instead of the hand, as illustrating the "Unity in the Type of Organization," he would undoubtedly have experienced much greater difficulty in producing a very popular volume, for which he received the very handsome sum of £1000. The treatise, it would appear, gave offence to no one, and, yet, it was a very bold proceeding to trace analogy between the boasted hand of man, the club-shaped pectoral extremity of the elephant, the bat's flying arm, and the fin of a fish.

THE RIBS,

I have remarked, are exceedingly delicate, and more resemble numerous, hair-like, semi-ossified, prolongations, giving attachment to the inter-costal muscles. In many species of fishes, as, for example, in the herring, these same ossified processes are very numerous; and, I think, by many anatomists, are considered ossified tendons of the muscles, not found in any other animals but fishes. In birds, we observe a tendency in tendinous prolongations of the muscles to become osseous, but these ossified tendons in birds, cannot be considered in any way analogous to the hair-like processes I now allude to.

THE LOCOMOTIVE ORGANS

in the shape of the pectoral and ventral fins, are not particularly well represented. No vestige of ventrals can be observed, and the pectorals are exceedingly small. The Ophisurus finds his food amongst the mud and stones, in the estuaries of rivers; and with the assistance of the cutis-muscle, already alluded to, will be able to make considerable way over the mud. I may remark, that the Murœna, or common eel, does not possess this abdominal cutis-muscle, but a thin layer of muscular fibres can be observed on each side of the caudal extremity, acting in a lateral movement of the tail, and facilitating the eel in progressing through the water.

THE MUSCULAR SYSTEM,

it will be observed, from the annexed table of weights, is greatly developed, and altogether connected with the spinal column—the pectoral fins being merely rudimentary, and the ventrals entirely wanting. A careful anatomical dissection would, no doubt, show that the anatomy of the human subject, was not essentially deviated from. It may suffice, however, to state, that it

consisted of four bundles, two on each side, divided by a fibrous aponeurosis, and numerous fine, hair-like bones attached, especially in the situation of the lateral line, and also to the skeleton. In treating of the skin, I have alluded to the cutis-muscles extending from the pharynx to the anus, as, no doubt, supplying the want of the usual pectorals and ventrals. In describing the skeleton, I have mentioned the development of lateral processes in the caudal portion of the spine, those processes were closely attached to the spinal muscles, and the great vascularity of the muscular fibre, indicated the constant use, and great power in all the lateral movements of the caudal extremity.

ORGANS OF SENSE.—*Smell.*

The nostrils opened on each side of the upper jaw, about half way from the tip of the jaw to the centre of the eye. They present a kind of representation of the alœ in the human subject, and, no doubt, could be closed, or opened, according to circumstances; and, indeed, I observed on the inner surface of the integuments, in the situation of the nostril, a series of fine semi-cartilaginous fibres sweeping around the situation of the nostril, resembling the radii supporting the membrane surrounding the gills: a bristle introduced into the nostrils, passed directly into the cavity lodging the brain.

Sight.

The eyes are protected (I cannot say concealed) by the integuments passing completely over the orbits, having no connection similar to a *tunica conjunctiva*, with the eye itself. The detached skin, however, when dried, exhibits a beautiful transparency, answering the purposes of a pane of glass, and protecting the eyeball, under all circumstances.

Hearing.

The single specimen I had, afforded no means of ascertaining the power of hearing, or state of the ossiculæ.

CIRCULATION, AND ORGANS OF RESPIRATION. (Fig. 8.)

The heart, remarkably small, but formed of an auricle, ventricle, arterial bull, and brachial artery, as in other fishes.

The tongue is edentulus.

Hyoid and Branchial apparatus so perfectly accord in the Ophisurus, with the type observed in fishes, as to leave no doubt as to what division of the vertebrata it belongs. The chief difference from that in other fishes, is in the Radii Branchiostegi, and in the extreme smallness of the Hyoid bones. The Radii of the Ophisurus (twelve on each side) are grouped in close juxtaposition, at their attachment to the hyoid, but, branching out, make a sweep round the operculum, nearly meeting on the dorsal line, and being intimately connected with the integuments, might escape the observation of the naturalist. The free margin of the branchiostegal membrane forms the anterior edge of the gill apertures, whilst the pectoral fins form, in a great measure, the posterior margin, evidently assisting the radii, branchiostegi, and membrane, in guarding and adjusting the all-important gill openings. The branchiæ appear to have been composed of little tufts. The state of the viscera prevented me from ascertaining the presence, or absence, of a swimming bladder.

ORGANS OF DIGESTION (Assimilating).

The Œsophagus is wide, and composed of three tunics; the muscular layer of great strength; the inner or mucous membrane, resembling the lining

membrane of the gizzard in birds, is raised into eight longitudinal folds. A finer arrangement of the longitudinal folds marks distinctly the commencement of the stomach, which terminates in a sharp point. The pyloric valve is placed about the centre of the stomach, and presents a complete obstruction to any thing passing to the intestine, independently of the vital phenomina. The duodenum, and the remainder of the intestinal tube is distended, but gradually contracts, and becomes nearly straight.

The duodenum, when divided longitudinally, exhibited a finely reticulated, honey-comb surface. No vestige of pancreatic cœca could be detected.

The liver, square-shaped, lay imbedded, as it were, between the œsophagus and intestine; it was of a pale brownish-yellow colour, soft and friable.

The kidneys, in position and structure, resembled those in the anatomy of the Murœna.

FOOD.

No organic remains could be detected in the stomach, or intestinal tube, and the utter absence of any fatty deposit was sufficiently curious; perhaps the specimen had just emerged from its winter quarters in the mud.

GENERATIVE ORGANS

resemble those of the eel, and being in their minimum state of development, or season, some difficulty occurred in even determining the sex.

TABLE OF MEASUREMENTS.

Recent Specimens.

	feet.	in.	lines.
Snout to tip of tail	2	11	0
nostrils	0	0	4½
centre of eye	0	0	10
angle of mouth	0	1	4
free margin of operculum	0	2	6
anus	1	1	6
Greatest circumference—centre of body	0	3	6

Viscera.

Tip of tongue to pyloric valve	0	5	0
Pyloric valve to extremity of stomach	0	4	6
Total	0	9	6
Pyloric valve to anus	0	10	0

	lbs.	oz.	grs.
Weight of entire specimen before dissection	0	8	0

Skeleton.

Weight of head	30 grains
„ „ tongue and branchial apparatus	10 „
„ „ spine, etc.	370 „
Total Weight	410 grains

ABSTRACT.

	lbs.	oz.	grs.
Weight of recent entire specimen . . .	0	8	0
Deduct weight of skeleton . . .	0	0	410
	0	7	70
Deduct weight of skin, 180 grains } „ „ viscera 320 „ } .	0	1	20
Weight of the muscles	0	6	50

Special.

Weight of single vertebra (the 80th being the largest) 1 grain.

Number of Vertebræ.

Body	110
Caudal	100
Total number	210

NOTE.—Number of Vertebræ determined by Dr. Knox:

Ophisurus	210
Eel (common)	110

ART. VIII.—*On the* BIRDS *of New Zealand.* By T. H. POTTS.

(With Illustrations.)

[*Read before the Wellington Philosophical Society, July* 17, 1869.]

INTRODUCTION.

THE settlers of New Zealand, so large a proportion of whom are engaged in rural occupations, which placing them in immediate contact with the works of nature, through observation and study ripening into confidential intercourse, will, doubtless, feel deeply indebted to Mr. Buller for his valuable essay on our Birds, which most interesting division of our Fauna exhibits a notable exception to the comparative dearth of animal life in these islands. When we consider, that from the absence of almost every variety of game, we are debarred the enjoyment of those sporting instincts and habits, which are characteristic of our countrymen wherever they may sojourn, the Natural History of our birds may be found an interesting and useful study, wherewith to beguile many a listless hour; wherever our pioneers of civilization are engaged in subduing the wilderness, near the grateful shade of the forest, in tending flocks on the hill pastures, or cultivating the level acres of the plains.

Nor is it for the merits of that interesting treatise only that we feel thus indebted to its author; its publication has called forth a critical review of it from the pen of Dr. Otto Finsch, of Bremen. The combined result has been of great advantage to the Student of Ornithology, by the removal of certain doubts and difficulties in the nomenclature, and the presentation of a nearly complete list of New Zealand birds, corrected to a recent date. Mr. Buller not only deserves well of his fellow-colonists for what he has done, and merits our thanks for benefits conferred, but we must feel prospectively grateful

inasmuch as he is labouring at a complete work on New Zealand Birds. As some time must, however, elapse before his work can be placed in the hands of the public, I beg to offer my small budget of information concerning the mode of nidification and breeding habits of several species, which have come under my own observation, many of which are rapidly becoming scarce. I do so, not only in the hope of its proving of some utility, however slight, but also that others may be induced to communicate their observations, even in a like imperfect shape, and thus lend their assistance in studying our page in the great Book of Nature.

Some of the information here given has been already forwarded to Mr. Buller, at his request, having been gathered from notes and memoranda, made by my sons, and myself, during a long residence in various districts of the Province of Canterbury, where we enjoyed favourable opportunities for pursuing a favourite study.

> "Some to the holly hedge
> Nestling repair, and to the thicket some;
> Some to the rude protection of the thorn
> Commit their feeble offspring: the cleft tree
> Offers its kind concealment to a few,
> Their food its insects, and its moss their nests.
> Others apart far in the grassy dale,
> Or roughening waste, their humble texture weave.
> But most in woodlands solitudes delight,
> In unfrequented glooms, or shaggy banks,
> Steep, and divided by a babbling brook,
> Whose murmurs soothe them all the live-long day,
> When by kind duty fix'd."—THOMSON.

The Birds of New Zealand present to the observing naturalist, most interesting studies in their breeding habits, and various modes of nidification, varying from the compactly-felted nest of the Rhipiduræ, or Mohouæ, through easy gradations, every step of which is instructive, till we reach the bare spray-washed rock, on which the Whalebird rears its hardy offspring. They offer to our notice examples of burrowers, troglodytes or semi-burrowers, ground-builders, parasites, and the more or less elaborately-finished structures, which are to be found amongst the incessorial families, in which division the faculty or instinct of bird architecture appears to reach the highest development. Any one who has enjoyed the opportunity, must have been filled with admiration, whilst watching and considering the varying conditions under which the young of different species are reared.* We see that some are fed in the nest till they are well-grown as the kingfisher and penguin; others may be said to assist the work of their parents, by following them as soon as they are hatched, and thus materially diminishing the labour of bringing up, by being themselves able to reach the locality of their food supply. Examples of these latter may be found amongst the Rallidæ, Charadriæ, and Anatidæ; whilst, as observed before, the young of the genera Halcyon and Spheniscus (true burrowing species) remain in their tunnelled holes till well-fledged and well-grown. Yet in the case of *Hymenolaimus melacorhynchus* (which has some claim to be classed as a burrower), a young brood may be noticed with the old birds, on a lake or river, riding on the rippling waves, and floating with buoyancy and ease for hours. The Charadriæ at the best are but indifferent

*In a recent work Professor Owen makes this suggestion, "A binary division of the class (Aves) may be founded on the condition of the newly-hatched young, which in some orders are able to run about, and provide food for themselves, the moment they quit the shell (aves precoces); whilst in others the young are excluded feeble, naked, blind, and dependent on their parents for support (aves altrices)." See *Anatomy of Vertebrata.*—OWEN.

nest builders, whilst some members of that restless, wary family make no attempt to provide artificial protection for their offspring, the young, warmly clothed with down, appear quite equal to the occasion, and accompany their parents with liveliness and activity. Amongst the Sternidæ and Laridæ, instances may be cited, showing equal indifference in providing shelter for their young; yet, it should be remarked, in these cases the young appear quite incapable of shifting for themselves, and must depend on the industry of the old birds for bringing their food supply to them for several weeks. Here the parental instinct is shown in the selection of the breeding place, the eggs being deposited on the shore of the fishing ground, from whence the food supply of the future family is to be procured; but they have fewer mouths to feed, as they seldom lay more than one or two eggs (*L. Scopulinus*, *S. Longipennis*). Now, if we turn, for the sake of comparison, to the incessorial genera, denizens of the bush, we shall find the callow nestling equally as helpless as the young in the case of the natatorial birds: but as they number many individuals to each nest, the tax on the energy of the old birds to supply the requisite amount of food, must cause, *pro tanto*, so much the greater labour, unless, indeed, the warmth of numbers closely packed in a well-built nest, should render a somewhat less abundant supply of food sufficient, than would be required to support and rear the exposed broods of the aquatic birds before mentioned.

Some of the Grallatoræ and Anatidæ are remarkable for the extraordinary efforts they make when endeavouring to allure the unwelcome intruder from the immediate neighbourhood of their eggs or young. They will assume lameness, flutter with drooping wing, or drop with a dismal cry into the simulated agony of a death struggle to mislead the wayfarer, but when their artifice has succeeded in enticing him to follow till a safe distance from their precious charge is reached, "they clap their well-fledged wings and bear away," leaving the astonished beholder to meditate on the folly of trusting to appearances.

Amongst the troglodytal birds (such as Nestor, Platycercus, etc.) white is the usual colour of the eggs, doubtless as a provision to render their position more readily seen in the dim twilight of the breeding place, consequently to be approached and incubated with less danger of accident. It is, however, amongst the ground-breeders that the colouring of the eggs elicits the admiration of the careful observer; in some instances (such as Anarynchus frontalis) so wonderfully does the colouring of the eggs harmonize with the prevailing tone of the ground on which they are deposited, that accident only would disclose their presence to the casual wanderer, besides the instance just given, *H. Longirostris*, *L. Scopulinus*, afford noteworthy examples of this peculiar property which offers such a reliable safeguard against the plundering propensities of bipeds, whether feathered or not.

The rapid diminution in the numbers of our birds (with the exception of a very few varieties, of which *Zosterops lateralis* is the most noticeable instance) must be apparent to everyone who has given the slightest consideration to the subject, it is a matter of deep regret that, in all probability, many species will have become extinct ere their habits can be sufficiently studied by the naturalist for their use, economy, and position in our Fauna to be correctly ascertained. To the future student of the natural history of our country, vague, unreliable traditions, a conflicting nomenclature, and the contorted productions of the taxidermist mounted in acrobatic and weird-like attitudes, will perhaps alone remain to fill up the hiatus. How far should we now have to travel to discover a bevy of Quail, in the seclusion of some very remote valley of the "back country," a straggler or two might be met with. Yet by referring to the "New Zealand Handbook," it may be noted that the large island in Port Cooper was named after this bird, from the number of Quail flushed there. The beautiful little Rails are now almost as scarce; in how few

streams or lakes could one now expect a sight of the noble White Crane, watching "with motionless regard," its finny prey, yet but twelve years since, the writer of this paper gave Lake Heron, in the Ashburton country, its name, from the numbers of this majestic bird, which frequented its shores, or soared above its surface with lazy, heavy flight. These are but a few names of rare birds from a list that is annually increasing; and it is a matter of no great difficulty to point to the causes, which have led to what must certainly be deemed a misfortune to the Colony.

As the country became occupied, the more remote districts rendered accessible by means of roads, as wide-spreading swamps were drained and brought into cultivation, extensive tracts of country stocked with cattle and sheep, above all, as the whole face of the country became changed by the repeated bush fires, it can be readily understood how these various incidents of civilization should so soon have effected such considerable changes in the condition of our feathered tribes. * To these other minor causes may be added, and, perhaps, contemplated with less satisfaction, the reckless gunner frequently killing for the mere love of slaughter, the self-complacent "new chum," with the inevitable firearms, even the learned *savant* will sometimes be tempted to destroy both old and young, especially of our rarer birds, a favourable opportunity of procuring choice and desirable specimens being too great for resistance; scientific zeal thus overcomes good policy, and consideration for the future. Would not the re-establishment of some of our rarer species (many of which are excellent as articles of food) form a worthy, if not a noble, object of ambition for our Acclimatization Societies to achieve? * The difficulties attending such an undertaking would necessarily be great, there is no doubt, but difficulties energetically encountered are seldom insuperable. To ensure anything like a successful issue being arrived at, certain conditions must be fulfilled, early action must be taken, an intelligent acquaintance with the habits of birds, would be indispensable, patience to endure considerable trouble, as well as occasional disappointment, and lastly, a small expenditure of money. However, a moderate outlay should not be an impediment to an undertaking of such interest with those institutions, which have been handsomely supported by private subscriptions, supplemented by liberal grants of public money.† The Parliament of New Zealand has taken steps to protect some of our birds, but however well legislative enactments may be framed, the people themselves can alone determine what shall be allowed to exist; looking at the rapid destruction threatening our noble forests, and in some cases our fisheries also, it must be admitted that the prospect of the preservation of our birds is the reverse of hopeful.

As a rule, we appear to live, work, and legislate for to-day, with not too much anxious thought for the to-morrow of those who are destined to succeed us. Whatever may have been the result in other countries which have been colonized by our race, whoever fairly writes the history of this country, will have to record how deeply the Anglo-Saxon *settler* has implanted his mark, by the alteration of the natural features it presented on his first arrival. Perhaps it would not be considered out of place to offer a few general, but very brief,

* "One of the exciting causes of the destruction of every living native animal that can be met with is the pretence of enriching our Museums, while at the same time the overstocked market in Europe render them, for the most part, unsaleable there; and it is a well-known fact, that the skins of Australian birds, etc., have been re-exported from England to Australia for sale."—See Dr. Bennett's "Gatherings of a Naturalist in Australia."

† Should our Acclimatizing Institutions require a precedent, they may refer to the "Bulletin de la Société Impériale Zoologique d' Acclimatation, 1864." Among the extraordinary prizes offered by the Imperial Society, February, 1864, may be found,—Reproduction in France of the Pinnated Grouse (*Tetrao Cupido*) la Gelinotte, medal of 1,000 francs.

remarks on the study of our ornithology, which presents a wide field for the instructive entertainment, even of those who do not enjoy the advantage of much out-of-door occupation, as diligent investigation will repay those who are disposed to devote time and attention to its careful consideration. The tegumentary system of birds is so remarkable and beautiful a feature, amongst the glories of Nature's handiwork, as at once to call for observation, the most heedless must be attracted by the exquisite arrangement of form and colour. Although man's chief interest in the feathered tribes centres, in the fact of their furnishing him with delicate and luxurious varieties of food, or amusement, and a mild excitement in the way of sport; yet several species are so lovely in their gorgeous trappings, that birds of many kinds are kept in a semi-domestic state, merely for the gratification their beauty imparts to the beholder. Vast numbers, more fortunate perhaps, are eagerly pursued and slain, not for economical purposes of supplying food or clothing, but that their rifled plumes may be worn as articles of personal adornment. Human vanity has long since established this custom so universally that neither age, sex or race appears exempt, and the chief of a Maori tribe doubtless feels as much pride in his feathered head-dress plucked from the beautiful train of the snow-white Kotuku, as the bedizened wearer of ostrich plumes, whether a prince or a peeress of one of the most civilized nations of Europe.

The Parroquet may be frequently observed in confinement, and the Tui, liveliest of our Meliphagidæ, quite as often perhaps barred within the limits of a dirty cage, has to exchange, for the dewy nectar of fresh bush flowers, a monotonous diet of soaked bread or biscuit, and for this unpalateable dole the unfortunate prisoner for life is expected to be lively and gay. The Maories of the South Island have long prepared the Mutton-bird, as a dainty article of food.

What can be more wonderful than the development from the inert contents of an egg, of so sprightly a creature as a bird; if we were not familiarized with this admirable and curious process of nature, it would be deemed miraculous; it really appears typical of the Creation, and this must have been felt, where the egg was looked upon as the symbol of the renovation of the living world, and the custom was introduced, of suspending an egg in Eastern Churches. A writer on the monasteries of the East says, "as the egg contains the elements of life, it was thought to be an emblem of the ark, in which were preserved the rudiments of the future world."

Passing over the embryological age, the period of incubation which represents the term of gestation amongst mammals, and the growth of the young in all its stages of dependence, our attention is arrested by the anatomical structure of this class of vertebrates. The peculiar arrangement of the osseous and muscular systems, from whence the power of locomotion in all their admirable variety are derived, should be carefully considered, flying, walking, hopping, climbing, swimming, or diving, from the constant exercise of which, birds depend for safety, or obtain their food supply.

A transient glance at the structure of their skulls and beaks will satisfy the enquirer how happily their forms are adapted for the habits and varying conditions of the life of different species. The strong hooked beak of Nestor, by the help of which it rapidly ascends the stems or branches of trees, is sufficiently powerful to rend down long strips of tough bark, such as that of *Fagus solandri;* the soft bill of Hymenolaimus enables it to secure small aquatic insects, caddis worms, etc., in the mountain creek; the slender curved mandibles of Recurvirostra are fitted for thrusting into the oozy slime of the swampy marsh; with its strong beak, the cosmopolitan Hæmatopus readily breaks the shell-armour of the various bivalves that pave the tide-washed mud flats of our harbours; the reason for the lateral curvature of the beak of the

Anarynchus, or Crook-billed Plover, as yet requires explanation, which can only be satisfactorily given from a closer observation of its habits. Compare the bones of Himantopus, the graceful wader, with those of Podiceps, or Sphœniscus, chief amongst divers, the wabbling, yet undulating gait of the latter, when hastening to the sea, gives it rather the appearance of a large water-rat than that of a bird, but how its awkwardness on shore is compensated for, anyone may judge who witnesses the ease and rapidity with which it dives beneath the swelling wave, by the aid of its fin-like wings. Notably, Fregata, Diomedia, Thalassidroma, with their enormous development of the bones and muscles of the wings, their consequent almost untiring flight,* offer the most remarkable contrast to many species, such as Apteryx, Ocydromus, and the wingless giant peculiar to our land, which perhaps has not been long extinct. It is interesting to note that it was from a bone of this genus that *the* instance of the perfection of skill to which the accomplished anatomist can attain, was exhibited, as all the world knows, by Professor Owen building up, from the study of a single bone, his theory of the gigantic bird, the correctness of which was afterwards corroborated by the discovery of ample remains of various species of Dinornis. Is it possible that the Moa was known to the ancient world? The following passage from Strabo would answer for a description of its pursuit by natives, quite as well as for the hunting of the Dodo of the Mauritius, or the Æpyornis of Madagascar. Writing of the countries washed by the Red Sea (Book xvi.), Strabo observes, "Above this nation is situated a small tribe, the Struthophagi (or bird-eaters), in whose country are birds the size of deer, which are unable to fly, but run with the swiftness of the ostrich. Some hunt them with bows and arrows, others covered with the skins of birds, they hide the right hand in the neck of the skin, and move it as the birds move their necks. With the left hand they scatter grain from a bag suspended to the side; they thus entice the birds till they drive them into pits, where the hunters dispatch them with cudgels. The skins are used both as clothes and as covering for beds." Such an ancient notice of a wingless bird is interesting.

The flight, migration, sight, and voice, of many of our species of birds, are all subjects of interest to those who are glad to learn something more of the world we live in.

When the Lark is flushed from her nest on the wide expanse of the tussock-covered plains, with what rare instinct or wonderful gift of sight must she be endowed, which enables her to find her nest amidst the myriads of tussocks presenting the same aspect, without a track, a tree, or even a rock, as a guide to aid her organ of locality. How true is the Bronze-winged Cuckoo to his appointment, almost to a day, the first week in October he announces, by his presence, that high spring has been reached, and the active labours of our portion of animated nature has commenced in earnest.

We cannot boast of possessing, amidst our bushes, rivals to those "melodious songsters of the grove" which wake up the woods and hedgerows of the Old Country, yet many of the notes and cries of our feathered race are peculiarly interesting, such as the song of the *Petroica albifrons*, the human-like whistle of the *Chrysococcyx lucidus*, the well-known chime of the Bellbird, the extraordinary sounds to which the white banded Tui gives utterance, the flute-like tones of the Crow or Wattle bird, the wailing call of the Weka; and the startling shriek of that night bird, frequently heard in the back country, which has not been identified as the call of any bird that has yet been described.

* After the memorable storms of July and August, 1867, in Lyall's Bay, amongst numbers of Hapuka and other fish that had been stranded, we observed several bodies of *Diomedea exulans*, that had perhaps been dashed against the rocky cliffs, by the violence of the storm.

For years attempts have been made to procure a specimen of this mysterious unknown, which will probably be found to belong to the families either of Strix or Podargus; it is to be hoped it may not turn out to be the man-liking bird thus mentioned by Fuller, "I have read of a bird which hath a face like, and yet will prey upon, a man, who coming to the water to drink, and finding there, by reflection, that he had killed one like himself, pineth away by degrees, and never afterward enjoyeth itself."

Already some of our rural settlers attach significance to the peculiar flight and cries of birds, as prognosticating changes in the weather, thus following out in their new home the like fancies or observations which have been handed down by their fathers from time immemorial; on this subject Cuvier wrote, "For the rest of their intellectual qualities, their rapid passage through the different regions of the air, and the lively and continued action of this element upon them, *enables them to anticipate the variations of the atmosphere*, in a manner of which we have no idea, and from which, has been attributed to them from all antiquity, by superstition, the power of announcing future events."

Embryological research as far as our birds are concerned is still a sealed book. This is a branch of science upon the importance of which Agassiz lays much stress; after speaking of the information he had acquired from the examination of bird embryos, he writes, "How very interesting it will be to continue this investigation among the tropical birds!—to see whether, for instance, the Toucan, with its gigantic bill, has, at a certain age, a bill like that of all other birds; whether the Spoonbill Ibis has, at the same age, nothing characteristic in the shape of its bill. No living naturalist could now tell you one word about all this." Investigations of this nature amongst the several genera peculiar to New Zealand, would be of value to science, and would offer an interesting field for new discoveries concerning ornithological facts, in our bright corner of the world, which the scientific naturalist has not yet found time or opportunity to lay bare.

Accuracy of description is so necessary to establish facts, that it is far preferable to give a few brief notes, the result of actual observation, rather than to supply pages of information gathered from hearsay; even in our humble researches, the untrustworthy character of report generally, has been experienced sufficiently often, to impart a certain amount of incredulity not easily shaken off; mythic treasures have so frequently eluded pursuit, when the scene has been reached that should have disclosed specimens of more than ordinary interest, that no difficulty is felt in understanding how often fable creeps in, and becomes, in a measure, blended with truth in matters relating to Natural History.

On the other hand it is far from safe to discard even the improbable, as imperfect description has before now converted the improbable into the apparently impossible, as a very early notice of the Hornbill will testify.*

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* In 1330, Odoric tells of a bird as big as a goose, with *two heads*. In 1672, P. Vincenzo Maria describes a bird, also as big as a goose, but with *two beaks*, the two being perfectly distinct, one going up and the other down; with the upper one he crows or croaks, with the lower he feeds, etc.—*Viaggio*, p. 401.

In 1796, Padre Paolino, who is usually more accurate, retrogrades; for he calls the bird "as big as an Ostrich." According to him, this bird, living on high mountains where water is scarce, has the second beak as a reservoir for a supply of that element. He says the Portuguese call it Passaro di duos bicos.—*Viag.*, p. 153.

Lastly, Lieut. Charles White describes the same bird in the Asiatic Researches. "It has a large double beak, or a large beak surmounted by a horn-like shaped mandible."—*Asiatic Res.*, iv., 401. The bird is a Hornbill, of which there are various species having casques or protuberances on the top of the bill, the office of which does not appear to be ascertained. How easy here to call Odoric a liar! but how unjust, when the matter has been explained.—*Cathay and the way thither*, Vol. i., p. 100.

Many writers of Natural History appear to have made a practice of copying from their predecessors: the inconvenience of this arrangement is manifest, in that errors were thus allowed a very protracted existence, such as the fables which were for centuries supposed to describe the natural habits of the Kingfisher, etc. The writer of this paper was long haunted by the vignette title of a popular work on British Birds, the engraving was supposed to give a correct representation of *Cindus aquaticus*, and nest; the latter as there figured, presented the conventional basin-shaped arrangement with eggs, all complete, the popular notion of a bird's nest in fact; now, in reality, the nest is a thick mossy dome-shaped structure, in which the pure-white eggs are concealed from view. Years after quite as great a shock was felt, when on inspecting a public collection, he found that if he placed reliance on what he saw before him, Falcons must have laid Pigeon's eggs, Seagulls had produced those of the Turkey, whilst the Crested Grebe had achieved a Duck's egg. Careless mystifications such as these, should be avoided by those who are expected to impart information, as *too improbable.*

An attempt to show, more clearly, the extent which the ravages of a few years have inflicted on the numbers of our birds, may perhaps be excused for the object in view, we will therefore endeavour even at the risk of being tedious, to represent such a scene of the past as one might reasonably expect to meet with, almost daily, during a considerable portion of the year, at the place indicated. One of the most favourable localities for observing the habits, acquiring a knowledge of the notes and cries, and watching the flight of various birds, was not far from the gorge of one of our great southern rivers, where the monotonous flatness of "the plains" gives way to a more broken and undulating surface, as an extensive range of hills is approached. This range is on one side flanked by low downs enclosing a few shallow lagoons, here and there sparsely-wooded gullies intersect the hills, from whence flow two or three brawling creeks, that join and deepen into a swift and silent stream crossing the grassy flat; the higher portion of this corner of "the plains" is stoney, whilst near the foot of the downs lies a swamp of no great extent.

Here upwards of thirty varieties of birds might be observed almost daily, and here too, or within a very moderate circuit, most of them breed.

Then our handsome Quail abounded, flying straight and low when flushed; the finding its slight humble nest filled with eggs, was no rare occurrence; or to see from amidst the snow-grass tussock, the Weka confidently emerge, or to hear the little Grass-bird utter its unchanging note u-tick, u-tick, as rising on feeble wings that just sustained it to the sheltering grass, beneath the spreading leaves of a neighbouring flax bush, whence perhaps the Tit (Petroica) darted to the ground from the tall flower-stalk, to snatch the larvæ of the grasshopper. Then the blue Pukeko, prince of Rails, often stalked through the raupo of the swamp, or the brown-streaked Bittern, with long ruffled neck, rose with deliberate flight; perchance hard by in the narrow outlet bounded by tufted stumps of carex, the light-eyed Teal slunk silently from view; or further on, where the creek widened to a noiseless pool, the little Grebe with rosy breast, dived and sported with restless activity; close by a group of sober Grey Ducks; whilst the watchful Paradise Drake basked on the sunny bank above, his beady eyes doubtless commanding a view of a certain snow-grass tussock, under the waving plumes of which, a cup-like nest of down might lie securely hid. Then perhaps amongst the tall feather-tufted tohe-tohe reeds, and saw-edged grass, a pair of Harriers had built their rough, flat-topped home, or floating high above on noiseless wing, alarmed the pyebald Redbill, that circles round on rapid wing, screeching its clamorous note; or we might watch the pied Stilt with long pink legs, outstretched rudder-like behind, making for the rush-fringed lagoon, to join its mates in wading near the margin of the pool,

whose placid surface, now broken into a thousand ripples, as it shivers beneath the touch of the passing breeze, laden with sweet perfume, collected from the thorny Discaria, the formal solitary Cordyline, or the creamy bells of the brown-leaved Epacris. Now perhaps behind a favouring flax bush, we watch the visitors that dot the surface of the water (amongst them, the Black Widgeon and variegated Shoveller were rarely to be seen) and observe some early flappers skimming along in hot pursuit of their insect prey. Crossing towards the higher stony ground over patches of gizzard-stones, and many a bleached bone, crumbling in decay, of the giant Moa, that tells a tale of days philosophers may dream of; perhaps the sprightly lark, with lively chirrup, mounts from its freckled eggs, or the banded Dotteril flies round with warning note, whilst its grey-clad young hide cunningly behind some stick or stone; or red-billed Terns gather round in screaming flocks, returning from a blackened patch of new-burnt ground, that stretches far out on the plains, whilst from many a beak dangles the writhing lizard; or maybe the slowly repeated twit, twit, of the red-breasted Plover chimes in, as it sidles slyly off with alternate run and halt, nor could you find its slight grassy nest till half a dozen times the ground had been stepped over. The rock-bound gully reached (the heights above, as New Year's day came round, ablaze with crimson Rata flowers), from the swift stream below, amidst its noisy brawling with the rocks, arose the plaintive whistle of the Blue Duck, as with soft-fringed bill it explored each little foaming eddy; or scrambling through the scrub, we might observe, on the rifted top of a huge lifeless tree, the great Black Shag, perched motionless; beneath, Bell-birds, with noisy blustering flutter, seek the konini, clinging to its brittle sprays, extract the honey of the pendant flowers; or high up, clear into the golden glow of sunshine, ascends the glistening Tui, discharging a whole volley of strange sounds; or perhaps from the rocky bush, the green-clad Parroquet descends, its harsh note repeated rapidly; where sand-flies gather thickest and irritate the rambler with their dusky swarms, the Fly-catchers, pied and black, flit around, then perching, spread their fan-like tails with twittering chatter, whilst from a bare branch above, the strong-billed Kingfisher keeps watch above the gurgling creek. Then we might note where the small striped Wren crept round the lichen-covered trunk, or moss-clothed branches of some spreading shrub, or the grey warbler (Piripiri) with quivering notes fluttered near its cosy, dome-shaped nest; perhaps on a huge blackbirch the Kaka might be seen rending down the bark in long ribbon strips, to reach the insect dainties that lay housed beneath; or, with rapid flapping wing, the Pigeon seeking the straight-stemmed Kohi, whilst concealed by the rising tiers of leafy canopy, the bronze-winged Cuckoo whistled from the topmost bough. Emerging from the bush's dusky light, into the full glare of noon, we might perhaps have seen the Quail-hawk, rapidly ascending with spiral flight, till it appeared like a dark speck against the cloudless sky, its shrill jarring scream distinctly heard the while. Descending through groves of formal Ti palms, the steep, stone-paved terraces of the great river that rushes in milky streams below, the large Grey Gull might perhaps be found feasting on the carcase of a sheep, stretched on a patch of dark-green tutu; or hard by the margin of the sandy spit, the little Gull was perched neat and trim as any quakeress, whilst the Black Stilt, with its uneasy cry of pink, pink, settled a few yards onwards, to lead us from its crouching young, or the Crook-billed Plover scuttled slowly off with outstretched wing. Those less common birds, the great White Crane, Avocet, and Spoonbill Duck were seen at rarer intervals.

Now the scene is changed, and so thoroughly; it seems almost like a dream that such things were. The wooded gulleys denuded of timber, show amidst blackened stumps, some isolated shrubs, still green, of olearea, panax, or

much-enduring coprosma; the constantly recurring bush fires have cleared off the stately Ti palms (so fragrant in early spring); dwarfed flax bushes, altered the condition of various grasses, improving some for grazing, effected a speedier drainage, and dried up the shallow lagoons. Thousands of sheep now depasture on that well-remembered corner of "the plains," on those gently-swelling downs; instead of the varied cries of birds we have the bleating of flocks, the bark of the colley as it *rounds up* its charge, the loud crack of the stockwhip, the hearty curse of the bullock driver delivered "ore rotundo;" these changes form part of the evidence that testifies to the progress of our civilization.

If from some of the causes thus pointed out, or the rapid rate at which the timber forests have been wasted or destroyed,* the introduction of bees (and the numbers of swarms met with in the bush may easily account for some diminution in the food of the Meliphagidæ), the spread of cats, and even rats, or from the feeble hold on life which appears to be shared by every living thing that is indigenous, whether animal or vegetable, when brought into contact with foreign influences, it should be deemed impossible to avert the impending fate which threatens the existence of many species of our native birds, we must endeavour to find some compensation for so great a misfortune, in the success which has attended the introduction of foreign birds in many parts of the country. The Pheasant, Partridge, and Californian Quail, are amongst the best of the game birds that may be considered as established amongst us. The Black Swan, introduced in Canterbury to check the growth of another foreigner (watercress), Shell Parroquet, Thrushes, Blackbirds, Larks, Chaffinches, Greenfinches, Sparrows, Starlings, etc., from increasing numbers, promise very soon to give additional interest to our rural scenery.

LIST OF BIRDS

DESCRIBED IN THIS PAPER, WITH THE MEASUREMENTS OF THEIR EGGS.

		Measurement of Eggs.			
		Length.		Breadth.	
No.		in.	lines.	in.	lines.
1.	Falco Novæ Zelandiæ, Gml.	2	0	1	6
2.	Circus assimilis, Jard.	1	11	1	6
7.	Halcyon vagans, Gray	1	0½	0	10½
10.	Prosthemadera Novæ Zelandiæ, Gml.	1	2	0	10
11.	Anthornis melanura, Sparrm.	0	11	0	8½
15.	Pogonornis cincta, Dubus.	0	9½	0	7
18.	Acanthisitta chloris, Sparmm.	0	7¼	0	6
19.	Mohoua ocrocephala, Gml.	0	10½	0	8
20.	Sphenœacus punctatus, Quoy.	0	10	0	7¾
25.	Gerygone assimilis, Buller	0	8	0	6
26.	Certhiparus Novæ Zelandiæ, Gml.				
27.	,, albicilla, Less.	0	10½	0	7½
29.	Petroica macrocephala, Gml.	0	9	0	7
31.	,, toi toi, Less. and Garn.	0	9	0	7
32.	,, longipes, Less. and Garn.				
33.	,, albifrons, Gml.	1	0	0	9
34.	Anthus Novæ Zelandiæ, Gml.	0	10½	0	8
35.	Zosterops lateralis, Lath.	0	8	0	6½

*According to a return recently laid before the Provincial Council, over upwards of 170,000 acres of bush land, have depasturing licenses been granted by the Waste Lands Board of the Province of Canterbury. Is it the interest of the licensees to preserve timber?

		in.	lines.	in.	lines.
37.	Rhipidura flabellifera, Gml.	0	8	0	6
38.	„ fuliginosa, Sparrm.	0	8	0	6
47.	Platycercus Novæ Zelandiæ, Sparrm.	1	1½	0	10
50.	„ auriceps, Kuhl.	0	11½	0	9½
51.	Nestor meridionalis, Gml.	1	9	1	3½
58.	Chrysococcyx lucidus, Gml.	0	9	0	6
60.	Coturnix Novæ Zelandiæ, Quoy.	1	3	0	11
61.	Apteryx australis, Shaw	5	1	3	4
62.	„ Oweni, Gould	4	6	2	7
63.	„ Mantelli, Bartl.	5	4	3	3
65.	Charadrius bicinctus	1	4	1	0
A. 65.	„ obscurus, Gml.	1	9	1	3
B. 65.	Anarhynchus frontalis, Quoy.	1	4½	1	0½
71.	Hæmatopus longirostris, Vieil.	2	3	1	7½
75.	Botaurus poicilopterus, Wagl.	2	1½	1	6
78.	Himantopus Novæ Zelandiæ, Gould	1	10	1	3
B. 78.	„ melas, Homb.	1	10	1	3
87.	Ocydromus australis, Sparmm.	2	2½	1	5½
91.	Porphyrio melanotus, Temm.	2	0	1	5½
92.	Casarca variegata, Gml.	2	7	1	10
93.	Anas superciliosa, Gml.	2	3	1	9
94.	„ chlorotis, Gray	2	5	1	10
96.	Fuligula Novæ Zelandiæ, Gml.	2	8	1	9
98.	Hymenolaimus melacorhynchus, Gml.	2	8½	1	9
99.	Podiceps rufipectus, Gray	1	9	1	0
100.	„ Hectori, Buller	2	4	1	7
104.	Spheniscus minor, Forst.	2	3	1	9
126.	Larus Dominicanus, Licht.	2	10	1	10
127.	„ scopulinus, Forst.	2	1	1	6
129.	Sterna caspia, Pall.	2	7	1	9
130.	„ longipennis, Nordm.	1	10	1	4
131.	„ antarctica, Forst.	1	6	1	1½
A. 131.	„ sp. (Sternula nereis), Qy.	1	4	0	11
139.	Graculus brevirostris, Gould	2	6	1	6½
142.	Dysporus serrator, Banks.	3	1½	1	10

It may be interesting to persons acquainted with the Oology of Europe, to institute a brief comparison between the eggs of some of our birds, and those of kindred European species; in some few, considerable contrast in size and shape, may be observed; whilst amongst others so little difference is to be discerned, that it would be difficult to decide, from transient inspection, of which hemisphere they are native.

The eggs of *Falco Novæ Zelandiæ* closely resemble those of *F. peregrinus*, in size, form, and colour; so also do those of *Circus assimilis* bear as striking a likeness to those of *C. rufus*. The eggs of *Halcyon vagans* are larger than those of *Alcedo ispida*, the same may be said of those of *Coturnix Novæ Zelandiæ*, when compared with those of *C. vulgaris*. To select the eggs of *Hæmatopus longirostris*, from a number of those of *H. Ostralegus*, would be difficult; nor would it be much less so to decide whether the Bittern's eggs were European or New Zealand; the eggs of *Himantopus melanopterus* strongly resemble those of our Stilts, the same remark will apply to those of *Podiceps minor* and *rufipectus*, respectively. With regard to the eggs of *P. cristatus*, they are smaller than those of *P. Hectori*. The eggs of *Sterna caspia* bear a very close resemblance in both hemispheres. The similarity between the eggs of *Sterna*

minuta, and the new species from the Rakaia, has already been pointed out. The egg of *Dysporous serrator* only differs by $1\frac{1}{2}$ lines in length, from that of *Sula alba* of Europe; whilst similar chalky encrustations may be found on either specimen.

No. 1.—Falco Novæ Zelandiæ, Gml.
Ka rewa rewa-tara.
Quail-hawk.

In New Zealand, the courageous family of the Raptores is very feebly represented, the honourable post, of head of the family must fairly be assigned to this bird, which is commonly known by the name of the Quail or Sparrow-hawk; "the hardy Sperhauke eke the Quales foe," as Chaucer has it. This bold little Falcon, which, a few years since, was so frequently seen, is now of comparatively rare occurrence. How seldom do we now hear that wild chattering scream, which gave notice of its approach, and spread alarm amongst the denizens of the poultry yard. Many instances might be cited of its daring courage and perseverance in pursuit of its prey, such as dashing into houses, penetrating to an inner room, striking its quarry, and clinging to it till ruthlessly knocked over with a stick. Years ago, when Quail shooting, how we have been troubled by the assiduous attendance of this bird, and have shot this dauntless fowler almost in the act of swooping off our game. We have noticed the female, with a Tui trussed in her talons, which she carried a considerable distance without a rest, when the male soared boldly in company, and kept watch and ward over his well-laden helpmate.

At present it is in the "back country" only, that we can hope to find its breeding-place, which is usually on a ledge of rock commanding a prospect over some extent of country. Such an out-look gives an advantage of no little value, of which the Falcon is not slow to avail itself, should such a bird as a Tui or Pigeon appear in sight.

Several of the breeding-places, which we have had opportunities of examining, have presented, in a remarkable degree, very similar conditions as regards situation. Amongst bold rocks on the mountain side, somewhat sheltered by a projecting or overhanging mass, appears to be the favourite site for rearing its young. The eggs very closely resemble those of *Falco peregrinus* of Europe, in colour, size, and shape, usually three in number, are deposited on any decayed vegetable matter, that wind or rain may have collected on the rocky ledge, for the efforts of this bird in the way of nest building are of the feeblest description. The eggs are of a rich reddish-brown, mottled over with darker shades of brown, sometimes the ground-colour is pale reddish-white, less suffused with the darker colour at the smaller end, broadly oval in shape, they measure 2 inches in length, with a diameter of 1 inch 6 lines. Some eggs taken from a range near the head-waters of the Rakaia, give measurements somewhat less than the above, with a yellowish, in place of reddish-brown colour. Young birds are covered with grey down at first, and assume a plumage of dark brown above, with breast of rufous-white spotted with brown, thighs slightly rufous. October, November, and December is the principal breeding season, and the localities we have noted for the eyries, are rocks near Cass's Peak, Governor's Bay, Malvern Hills, River Potts, Mount Harper, etc.

Notes.—Oct. 10—Young Quail-hawks, near the home paddocks on the Rangitata River.

Nov. 8—Above the upper gorge of the Ashburton or Haketere River, found a nesting-place on the bare soil, sheltered by a large isolated rock; two young birds, covered with grey down, old birds very bold in defence of their young.

No. 2.—Circus assimilis, Jard.
Kahu.
Harrier.

One of the commonest of the larger birds met with on "the plains." From its depredations on poultry of all kinds, game, etc., great numbers of this fine Harrier are annually destroyed by means of the gun, poison, or the trap. Over a lambing flock it may be frequently noticed soaring with wide circling flight. On a weakly lamb its attack commences by picking out the eyes. Birds it carefully plucks before it begins its meal. It is not an unusual occurrence to find it with a young flapper, almost as neatly plucked as though the work had been performed by the skilful hand of a poulterer. We found, on one occasion, a good sized Shag which had been thus operated upon; this was in winter time (July), and shows it has sufficient strength and courage to attack and destroy a bird of considerable size and power. Its favourite building-place appears to be a low-lying situation amongst swamps, the margins of lagoons, etc. The nest, built on the ground, is made of coarse grasses, such as tohe-tohe, raised sometimes about a foot in height, rather flat on the top. We have found it partly constructed with pieces of the thorny Discaria, and the dead flower-stems of the large Aciphylla, above which prickly materials grass has been carefully placed. The eggs, usually four in number, are white; when perforated, and held against the light, the interior shows a deep green; length, 1 inch 11 lines, with a breadth of 1 inch 6 lines.

A pair of these birds made use of the same nesting-place year after year, amongst some strong tohe-tohe, close to the Ashburton River. We took from this nest an egg, which had been entirely covered up with the materials which had been brought to renovate the nest, at a period, subsequent to the breeding time, at which this egg had been laid.

From our memoranda, the months of November and December appear to be the height of the breeding season; it is found moulting in February; occasionally fine old specimens are met with, in which the whole plumage has assumed quite a light tone of colour; this is so conspicuous in some individuals, that some collectors endeavour to persuade themselves that a new species has been discovered. Perhaps the noiseless flight of this bird should be noted. When swooping on its quarry, the clean long tarsi enables the observer to see the action of the feet, the rapid contraction and expansion of the toes, when striking at its prey; should this prove too large, or too heavy, to be swooped off at once, the Harrier will drag it a considerable distance, apparently changing its hold frequently, accompanied with much noiseless fluttering of the wings, each time it strikes out its sharply armed foot to obtain a fresh grasp. To give some idea of the numbers of this hawk that are annually destroyed, it may be mentioned, that on the Cheviot Hills station, ten to twelve per day were frequently killed, and that it would be within compass to reckon that upwards of 1,000 hawks per annum had been thus accounted for during the last two or three years; amongst these were a few of the *Falco N.Z.* It will not create surprise to learn, that on this run rats are most abundant. On a farm on the Halswell, as many as fifteen were found poisoned in one morning. On another farm in this neighbourhood, numbers have been trapped by the use of a common rat-gin fixed on the top of a Ti palm.

No. 7.—Halcyon vagans, Gray.
Kotare.
Kingfisher.

One of our burrowing species. The tunnel-like hole, which forms the approach to its nest, is found sometimes in a bank, and, perhaps, quite as often

in a tree. On examining one of these holes, in a bank not far from the sea beach, the floor or bottom was observed to incline slightly upwards from the entrance, the eggs, deposited on the remains of crustaceæ, were not more than one foot back from the outside of the hole. When a tree has been selected for its home, we have been led sometimes to the discovery, by observing the quantity of chips lying beneath; its powerful bill soon excavates a nesting-place in the partially decayed wood. The situation varies from a few feet to above thirty feet from the ground (See Plate 4, Fig. 1). The eggs are pure glossy-white, delicate, and very beautiful, more fragile, perhaps, than those of most other species, oval in shape, with a length of 1 inch ½ line, by a breadth of 10½ lines. After hatching, the nest is carefully cleared of the broken shells. The young remain in the nest till well-fledged, and, apparently, almost full-grown. On examining the castings of the Kingfisher, which are often to be met with in abundance near a nest containing young, we have observed that the external wing-cases of coleopteræ, have formed one of the principal ingredients of the pellets. We have noted that a nest from which the young emerged late in November, again contained eggs in January. Our Halcyon must lay a much smaller number of eggs than the English Kingfisher. Although this bird may be constantly seen occupying some prominent branch, or stake, when watching for its prey (which, by the way, is of a very miscellaneous character), yet, when approaching or leaving its nest, it always, where possible, seeks the screen of overhanging trees, as it swiftly darts through the gully, permitting but a glimpse of its bright showy feathers. Should any one approach too close to the neighbourhood of its breeding-hole, the parent bird utters a low cry, like cree, cree, cree, frequently repeated. Our bird is much more sociable than its European relative, which is so remarkable for its solitary habits, that it has been stated, that the male and female only associate together at the breeding season: we have counted as many as eight of our Kingfishers sitting in company; after a heavy rain we have observed, on our lawn, several of the croquet hoops occupied at one time by these striking-looking birds. It is rarely to be seen on the ground; after darting down, either in the water, or on land, and securing its booty, it immediately flies with it to some perch, or post of vantage, and prepares it for deglutition, by administering some smart blows with its bill, the sound of which may often be distinctly heard. During the breeding season it indulges in a monotonous call of chimp, chimp, chimp, then a pause, the call and pause alternating for a considerable time. Fish, crustaceæ, young birds, mice, coleopteræ, bees, and other insects, furnish some portion of the food-supply of the Kingfisher; we have often noticed its rapid dart at a brood of young chickens. This bird is one of those fortunate species, whose numbers seem rather to increase than diminish at the approach of civilization.

The name of Halcyon given by ornithologists to this species, carries us far back into the very early days of Natural History. The history of its European congener was enveloped in poetic fables for centuries; probably no other bird, whose habits could be so easily observed, has been so universally the subject of groundless tales, or superstitious regard,—perhaps the recital of some of these notices may be excused. Aristotle, after a fair description of the bird, gravely states: "Its nest resembles the marine balls which are called *halosachnæ*, except in colour, for they are red; in form it resembles those sicyæ (cucurbits) which have long necks." Again, he says: "This bird hatches its young about the time of the winter solstice. Whereupon fine days occurring at this season are called *Halcyon* days." Omitting the fabulous accounts of many ancient authors, let us peruse the account of the philosopher of a more recent date, on the breeding habits of this wonderful bird; thus quaintly wrote Montaigne:—

"Mais ce que l'experience apprend à ceux qui voyagent par mer et notamment en la mer de Sicile, de la condition des halcyons, surpasse toute humaine cogitation. De quelle espece d'animaux a jamais Nature tant honoré les couches, la naissance, et l'enfantement? car les Poëtes disent bien qu'une seule isle de Delos, estant auparavant vagante, fut affermie, pour le service de l'enfantement de Latone: mais Dieu a voulu que toute la mer fut arrestée, affermie, et applanie, sans vagues, sans vents, et sans pluye, cependant que l'halcyon fait ses petits, qui est justement environ le Solstice, le plus court jour de l'an: et par son privilege nous avons sept jours et sept nuicts, au fin cœur de l'hyver que nous pouvons naviguer sans danger. Leur femelles ne recognoissent autre masle que le leur propre: l'assistant toute leur vie sans jamais l'âbandonner: s'il vient à estre debile et cassé, elles le chargent sur leurs espaules, le portent partout, et le servent jusques à la mort.

"Mais aucune suffisance n'a encore peu atteindre à la cognoissance de cette merveillense fabrique, dequoy l'halcyon compose le nid pour ses petits, ny en deviner la matiere. Plutarque, qui en a veu et manié plusieurs, pense que ce soit des arestes de quelque poisson qu'elle conjoinct et lie ensemble, les entrelassent les unes de long les autres de travers, et adjoustant des courbes et des arrondissemens, tellement qu'enfin elle en forme un vaisseau rond prest à voguer: puis quand elle a parachevé de le construire, elle le porte au batement du flot marin, là où la mer le battant tout doucement, luy enseigne à redouber ce qui n'est pas bien lié, et à mieux fortifier aux endroits où elle void que sa structure se desment, et se lasche pour les coups de mer; et au contraire ce qui est bien joinct, le batement de la mer le vous estreinct, et vous le serre de sorte, qu'il ne se peut ny rompre ny dissoudre, ou endommager à coups de pierre, ny de fer, si ce n'est à toute peine. Et ce qui plus est à admirer, c'est la proportion et figure de la concavité du dedans: car elle est composée et proportionée de maniere qu'elle ne peut recevoir ny admettre autre chose, que l'oiseau qui l'a bastie: car à toute autre chose, elle est impenetrable, close et fermée, tellement qu'il ny peut rien entrer, nou pas l'eau de la mer seulement. Voyla une description bien claire de ce bastiment et empruntée de bon lieu: toutesfois il me semble qu'elle ne nous esclaircit pas oncor suffisamment la difficulté de cette architecture. Or de quelle vanité nous peut il partir, de loger au dessous de nous, et d'interpreter desdaigneusement les effects que nous ne pouvons imiter ny comprendre?"

Sir Thomas Browne, the exposer of vulgar errors, in his "Pseudodoxia Epidemica," after stating the results of actual experiments, which enabled him to contradict the common notion, that a Kingfisher, suspended by the bill, would show from what quarter the wind blew, yet, apparently, received the ancient fable of the halcyon days without any distrust, for thus he wrote concerning the peculiar relations existing between this bird and the winds:—"More especially remarkable in the time of their nidulation and bringing forth their young. For at that time, which happeneth about the brumal solstice, it hath been observed, even unto a proverb, that the sea is calm, and the winds do cease, till the young ones are excluded, and forsake their nest, which floateth upon the sea, and by the roughness of the winds, might otherwise be overwhelmed. But how far hereby to magnify their prediction we have no certain rule; for whether out of any particular pre-notion they choose to sit at this time, or whether it be thus contrived by concurrence of causes, and providence of nature, securing every species in their production, is not yet determined." It would occupy too much space to mention the names of naturalists and writers who adopted similar romantic tales, each of whom was, of course, supposed to be narrating a particular and veracious account of the extraordinary mode of nidification of the Halcyon. Mr. Gould dissipated,

at last, whatever might have remained of these clouds of fable, by depositing the nest, entire, in the British Museum; a feat, the difficulties attending which were so well appreciated by all bird-nesters, that there was a report, or tradition, throughout many parts of England, that the authorities of the British Museum had offered a reward of £100 for a perfect nest of the Kingfisher. For a full account of Mr. Gould's exploit, see "Homes without Hands."

Shakespeare, in "King Lear," and several other writers, allude to the superstitious idea, that, if suspended by a thread from the ceiling, with windows and doors closed, the Kingfisher would turn its bill towards the quarter from whence the wind blew.

Amongst numerous other virtues, it was supposed to be a protection against thunder, against the ravages of the moth in woollen cloth, to be able to increase hidden treasure, to bestow grace and beauty on the person who carried it, and enjoyed the power of renewing its plumage, after death, by moulting.

No. 10.—Prosthemadera Novæ Zelandiæ, Gml.
Tui.
Parson-bird.

We have but seldom found the nest of this very common bird, whose varied notes break upon the stillness of the bush. Wherever we have met with its nest, it has been rather on the outskirts than in the depth of the bush itself. The Parson-bird seems thoroughly joyous only in the full glow of sunlight, where it may be seen in numbers, darting upwards far above the highest trees, and revelling in its free stretch of wing, now and then playfully pursuing some smaller bird, till it seeks the shelter of a friendly bush.

We have found the nest from twelve to thirty feet from the ground, and have noticed that whether against a White pine, or Black birch, there has been a sheltering cluster of Rubus, with its sharp, recurved prickles, beneath which the structure has been concealed. We have found it more than once near the top of a *Myrsine Urvillei*, over which the Rubus has thrown its straggling cords, forming a prickly canopy most difficult to penetrate. The nest, rather large, made of slender sprays intermixed with moss, and the wool or down of Tree-ferns (*Cyathea dealbata*), lined with fine bents of Poa grass; the dimensions we noted of a nest are as follows: across the top, from outside of wall to outside of wall, 9 inches, diameter of cavity, 3 inches 6 lines, with a depth of 2 inches. The eggs, usually three or four in number, are white, or with the slightest tinge of pink, marbled with rust-red veins, most numerous towards the larger end, rather pyriform in shape, they measure 1 inch 2 lines in length, by 10 lines in breadth. The nest containing young is sometimes stained deep purple, from the juice of the Konini berries (*Fuchsia excorticata*). On one occasion, the young, unable to fly, on being alarmed fluttered out of the nest to the ground, a fall of about twelve feet, the next day they were found safely ensconced within the nest, looking quite happy; this could only have been effected through the assistance of the parent birds. The Tui is rather combative whilst the young require feeding, even when they can fly well, it may be observed driving away the Kingfisher and Bell-bird from the trees in which its young are lodged. However much the white-tufted Tui may add to the interest of our forest scenery by the beauty of its glossy plumage, the gaiety which distinguishes its flight, or the wild outburst of its joyful notes, in the eyes of the omnivorous settler, it possesses the higher merit of furnishing a savoury article of food, and no weak sentimental feeling saves it from the camp-oven. It is frequently kept in confinement, and at one time many were sent to the neighbouring colonies. (See Plate 6, Fig. 1).

No. 11.—Anthornis melanura, Sparrm.
Koromako.
Bell-bird.

Everyone who has rambled through the bush, or even strayed amongst the shrubby thickets that fringe our numerous gullies, must have become familiar with the clear metallic ring of the Bell-bird's note. It may be said to sing matins and vespers for the warblers of the bush, as it is at the grey break of dawn, and the still hour that closes in the day, that its chime strikes clearest on the ear. It is comparatively silent during the noontide heat, unless some few individuals meet on a tree or shrub, that offers a tempting show of honey-bearing blossoms, a note or two is briefly sounded, the numbers rapidly increase; after much noisy fluttering of wings, a gush of clanging melody bursts forth from a score of quivering throats, forming a concert of inharmonious, yet most pleasing sounds. Probably Cook indicated the Bell-bird, then in a comparatively unmolested state, when he wrote, "the ship lay at the distance of somewhat less than a quarter of a mile from the shore, and in the morning we were awakened by the singing of the birds; the number was incredible, and they seemed to strain their throats in emulation of each other. This wild melody was infinitely superior to any that we had ever heard of the same kind; it seemed to be like small bells, most exquisitely tuned, and perhaps the distance and the water between, might be of no small advantage to the sound." Nor does this cheerful bird confine itself to the bush, it frequents our gardens and shrubberies, and especially affects the blossoms of the Fuchsia, Tritoma, Acacia, etc. The berries of various Coprosmas, and that of the Konini, it greedily devours; it may be frequently observed fluttering heavily in pursuit of a moth. It is very easily snared with a noose at the end of a tohe reed; in confinement it feeds on soaked bread, etc. Whilst the *Phormium tenax* is in blossom, many Bell-birds may be observed with their head feathers dyed orange-red, from contact with the pollen and honey, whilst extracting a delicious repast from the flax blooms. It has been stated that zealous ornithologists have deemed the bird thus decorated, a new species.

Placed at no great elevation from the ground, the nest may be found in a variety of positions, but we certainly have noticed it most frequently beneath a sheltering canopy of "Bush-lawyer" (*Rubus australis.*) It is rather flat, and loosely constructed of sprays, grass, moss, etc., well lined with feathers. On examining the foundation of a nest, we found green sprays of Manuka amongst the interlaced materials, a fact which disclosed the proof of the power of the bill of this honey-sucker in breaking off such tough twigs. From wall to wall, across the top, the nest measures about 5 inches, diameter of cavity, 2 inches 9 lines, depth inside, about 2 inches. We fancy that the lining feathers are selected in such a manner as to afford some evidence of harmony of colour in their arrangement; as, for instance, we have noted specimens, with the inner lining entirely composed of the red feathers of the Kaka, another adorned with the green feathers of the Parroquet; near the farm, where many kinds of poultry are kept, we have had instances of lining, white, black, speckled, buff, etc., but uniformity of colour has been displayed. The eggs, four in number, are white with reddish specks, sometimes the ground-colour exhibits a delicate pinkish tinge; they measure in length 11 lines, with a breadth of 8½ lines. We must have peered into scores of nests, in various parts of the country, but we have never yet been fortunate enough to encounter such a prize as one containing "seven eggs, spotted with blue, upon a brown ground," ascribed to this bird by the Rev. R. Taylor, in his work "Te Ika a Maui." The breeding-season extends from the commencement of spring, throughout the summer

months. We have discovered the nest in an old flower-branch of the Ti palm (*Cordyline australis*). (See Plate 5, Fig. 1.)

NOTE.—Feb. 2, 1868—Bell-bird building; that would give the breeding season a duration of about six months.

No. 15.—POGONORNIS CINCTA, Dubus.

A nest, assigned to this bird, was found in the bush above the Kaiwarawara stream, not far from Wellington; it contained one egg, rather oval in form, somewhat pointed at each end, measuring 9 lines in length, with a breadth of 7 lines; the whole surface clouded over with pale rufous-brown.

The nest, with thin walls, and of shallow form, was built of sprays, above which were laid fibres and dry rootlets of Tree-fern; fine grass was used for the lining, over which cow-hair was laid, and measured, across the top, 4 inches 9 lines, cavity 2 inches 4 lines, depth 1 inch 4 lines. This description is from the specimen in the Colonial Museum, Wellington.

No. 18.—ACANTHISITTA CHLORIS, Sparrm.
Pi wau wau.
Wren.

This, the smallest of our birds, is usually seen in pairs, flying low, with a feeble, jerky style of flight; more frequently it is met with creeping amongst the lichens and mosses that decorate the stems and branches of our forest trees. We have found the nest in a small hole in the trunk of a Fagus. Once a nest was discovered, very cleverly built in a roll of bark, that hung suspended in a thicket of climbing Convolvulus. (See Plate 4, Fig. 2).

The eggs are said to be very numerous sometimes, although four or five have been the most we have observed to a nest; like those of nearly all troglodytal birds, they are white and glossy; ovoiconically shaped, they measure 7¼ lines in length, by 6 lines broad. We have a note of the Wren breeding in August.

No. 19.—MOHOUA OCHROCEPHALA, Gml.
Mohoua.
Canary.

Although we have not observed this bird anywhere on "the plains," or on the lower ground of the "bays," yet as soon as one ascends the bushy gullies of the hills, the Canary is sure to pay a reconnoitering visit; with sharp strident call, it summons its companions, and the trees around will soon disclose the golden breasts and heads of these active arboreals, as they peer down on the intruder with noisy clamour. With restless movements, they creep round, above, and below the leafy branches, in their insect search. We have watched them on the ground, busily scratching and pecking between the huge moss-clothed roots of the lofty trees that tower above. The nest measuring across the top, 3 inches 3 lines, with a depth of 1 inch 4 lines, is a beautifully compact structure, cup-shaped, principally of moss, very closely felted, and neatly interwoven with webs of spiders. (See Plate 5, Fig. 2). In the hollow trunk of the Broad-leaf, it is sometimes found, and occasionally in a decaying Black Birch. Eggs white, with very small faint specks of red, nearly 11 lines in length, with a breadth of 8½ lines. We have a specimen of the nest and eggs from the River Wilberforce.

No. 20.—SPHENŒACUS PUNCTATUS, Quoy. and Gaim.
Mata.
Grass-bird, Grass-pheasant, Utick.

Some years ago the monotonous note of this little bird might be heard in almost any place, where tall tohe-tohe reeds, or the waving leaves of the *Carex*

virgata, indicated marshy ground; now it is rapidly disappearing, as the swamps are becoming drained. As its very feeble power of flight is unable to save it from the bush fires, we anticipate it must become extinct, on "the plains," at no very distant date. From its call, it is in some places named the Utick. The nest, inclining somewhat to an oval shape, and measuring about three inches across, is made of grass leaves, so frail in its construction, that the walls may be seen through, consequently it is a difficult specimen to obtain in a perfect state (See Plate 5, Fig. 4); a few feathers, usually those of the Pukeko, are added to the grass leaves, and sometimes a small tuft or two of wool. The situation is, most frequently, in a tussock, a few inches above the level of the ground. The eggs, three or four in number, are white, speckled with a beautiful tint of reddish-purple, which at once readily distinguishes them from those of any other bird; ovoiconical in form, they measure, through the axis, 10 lines, with a diameter of 7¾ lines.

NOTES.—Nov. 4—Nest containing three young birds, in a tussock, at the edge of a wide creek.

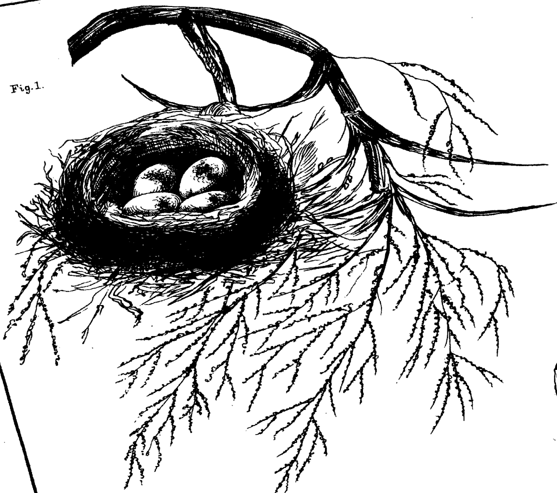
Nov. 7—Nest with four eggs, in a swamp by the Hororata stream, in the Malvern Hills.

No. 25.—GERYGONE ASSIMILIS, Buller.
Piripiri.
Warbler, Teetotum.

This cheerful little warbler is a pensile nest-builder, and one of the earliest breeders; its neat, domed nest may be often found, in August, suspended in some bushy Manuka or Olearia. The nest may be called somewhat pear-shaped, with a small entrance near the middle, above which is often affixed a kind of porch (See Plate 6, Fig. 3), it is suspended by its top, and kept steady from swaying in the breeze, by slight fastenings to a spray or two, acting as guys. Moss enters largely into its construction, very frequently wool; we have examined one, the greater part of which was composed of wool; cobwebs are freely made use of, to felt and bind the materials into a compact mass. We have a nest before us, taken from the fork of a Willow tree, at least twenty-five feet from the ground; it is rather larger than usual, and almost wholly constructed of poultry feathers and cobwebs, and is felted into a compact, firm structure, the porch and its foundation, beneath the entrance, is strengthened and kept in shape by fine roots carefully interwoven with green cobwebs; here and there may be found pieces of thread, string, coloured worsted, picked up from the garden or yard; the interior is thickly lined with feathers (See Plate 6, Fig. 2), this nest is evidently composed of materials, which would not have been made use of so freely, but for its firm and sheltered position in the fork of the willow, the most exposed part only being strengthened with stiff material.

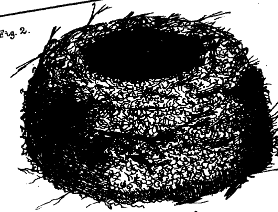
Sometimes, yet rarely, the nest is built in a less elaborate manner, without either dome or porch, the form of the structure being adapted to the peculiarities of the situation chosen; the principle of suspension is likewise occasionally abandoned. Five or six eggs are usually found to a nest, they are white, with red spots, ovoiconical in shape, 8 lines in length, with a breadth of 6 lines. No bird suffers so frequently from the imposition of the golden-winged Cuckoo, as the grey Warbler. We have several times observed a pair of these industrious little insect-eaters, feeding a young parasite larger than themselves. The Cuckoo only arrives in October, when the warmth of Spring is well established; and one reason for the selection of the Warbler's home, in addition to its pencile character, appears to us to be, because from its shape and structure it is the warmest nest, to be found, for rearing so tender a bird as the Chrysococcyx, our gay visitor, during the spring and summer months.

Fig. 1.



Nest and Eggs of
ANTHORNIS MELANURA.
In an old flower spike of Cordyline Australis.

Fig. 2.



Nest of
MOHOUA OCHROCEPHALA

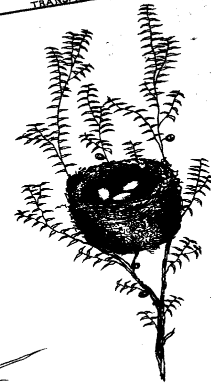


Fig. 3.

Nest and Eggs of
ZOSTEROPS LATERALIS.
In a branch of Leptospermum scoparium.

Fig. 4.

Nest and Eggs of
SPHENŒACUS PUNCTATUS.

To accompany Paper
by
T. H. POTTS.

T.H. Potts del. J. Buchanan lith.

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NOTE.—We have found eggs of the Warbler quite white, doubtless the produce of young birds. As yet we have failed to observe any such distinctive features, either in the structure or habits of these Warblers, that they should be classed as separate species, under the names of *flaviventris* and *assimilis*. We adhere to *assimilis*, as is adopted in the collection in the Canterbury Museum.

No. 26.—CERTHIPARUS NOVÆ ZELANDIÆ, Gml.
Brown Creeper; Brown Canary.

Although this Creeper may be seen in almost every bush, from the coast to the distant Alpine Ranges, we have only once found its nest. This was in the month of December, far above the Rangitata Gorge. The nest, containing three young birds, was compactly built of moss, with a few feathers, placed in a Black-birch, between the trunk and a spur, from whence sprouted out a thick tuft of dwarfish sprays, about seven feet from the ground.

No. 27.—CERTHIPARUS ALBICILLA, Less.
Mohoua.

This bird appears sufficiently common, about the bush above Wellington, for its habits to be well studied. There are several specimens of the nest and eggs in the Colonial Museum, Wellington. The nest is a very compact structure, having very thick walls, and in its style of architecture bears a strong resemblance to that of *M. Ochrocephala*, although, in some instances, different materials are used. In the one before us, different kinds of soft grass and moss form the staple, well-felted and interwoven with webs, lichens, and the down of tree-ferns; it measures 4 inches 1 line across the top, cavity 1 inch 10 lines in diameter, 1 inch 4 lines deep. Eggs white, or with very faint specks of pink, measure 10½ lines in length, with a breadth of 7½ lines.

No. 29.—PETROICA MACROCEPHALA, Gml.
Ngirungiru. Piro piro.
Tomtit.

This familiar little bird is one of the more elaborate nest-builders amongst the denizens of the bush, or rather its outskirts.

It adapts itself, in a manner, to civilization, frequenting gardens, and may be seen perched on a bough, ready to pounce on the grubs the gardener's spade may bring to light, reminding one very much of the habits of the Red-breast at home.

The nest varies much in shape according to position; frequently we have found it in holes of trees; a favourite site is immediately under the head of the ti tree (*Cordyline australis*). Two nests we presented to the Canterbury Museum, were of remarkable shape; one, a firm compact structure, placed in the forked head of a ti tree, resembled a very neat moss basket, with a handle across the top; the second, also from a ti tree, from, perhaps, the foundation slipping between the leaves, was built up till it reached the great length of sixteen inches. (See Plate 4, Fig. 4). We have found others placed on a rock, and one, now in the Colonial Museum, was built between the brace and shingles in the roof of an empty cottage.

The nest is neatly and firmly built of a variety of materials, carefully and neatly interwoven; moss, grass-bents, slender sprays, the down or wool of the tree-fern, cobwebs, and feathers, warmly line the interior. Four eggs is the usual number laid, though we have been told of more having been found; they are white, with grey speckles, most numerous towards the larger end, 9 lines long and 7 lines broad. A nest built in a ti tree, close to a pathway,

was almost daily visited by the child who had made the discovery, and the eggs inspected; when hatched the young were now and then handled, yet the confidence of the old birds carried them through this trying ordeal, and their young ones were successfully reared.

This is one of the few birds, of whose extinction we are happy to believe there is no danger; it is most useful as an insect eater, it is one of the latest to retire to rest, and may be often observed perched on the trunk of a tree, in a posture by which its body is almost at a right angle with the tree. The nests, described above, were found about Ohinitahi, where birds are as much encouraged, and as little disturbed as possible. Last summer another specimen was noticed, which had been built upon an old nest, making a solid mossy structure, measuring about one foot from top to bottom. The usual dimensions of the nest are as follows:—Across from outside of wall to outside, 5 inches; cavity 2 inches 6 lines, with a depth of 1 inch 6 lines.

No. 31.—Petroica toitoi, Less and Garn.
Tit.

Whatever distinguishing features, scientific research may have discovered, which allows specific differences between *P. Dieffenbachi* and *P. toitoi*, we fear they are not generally appreciated or understood. Perhaps this may be a fair opportunity of pointing out that the nomenclature of our birds still requires attention, and, above all, *settlement;* to the enquiring student of ornithology, scarcely anything can exceed the perplexity and embarrassment which is caused by a conflicting nomenclature. To give one instance: *Anarynchus frontalis* appears in Dieffenbach's list; since then we have noticed it as *Charadrius*, *Hœmatopus*, and now *Anarynchus* once more. Let us hope this may be the last change. We have often observed a Petroica, whose favourite haunt appeared to be amongst large areas of flax bushes (*Phormium tenax*), but confess we could not undertake to decide to which of the two species, named above, the Tit, to which we have referred, belonged; nor is there, unfortunately, any complete type collection, either in Wellington or Christchurch, which could decide any doubt that might be entertained on the subject. We have a set of eggs in our collection, which we are inclined to assign to the *P. toitoi;* they are slightly more inclined to pyriform, in shape, than those of *P. Macrocephala*, white, with marks of purplish-grey towards the larger end, and measure 9 lines in length, with a breadth of 7 lines.

No. 32.—Petroica longipes, Less. and Garn.
Robin.

In the Colonial Museum, Wellington, there is a specimen of the nest and eggs of this bird.

The nest, compactly built of moss, fine roots, web, and tree-fern down, is more neatly finished than that of *P. albifrons*. The eggs, ovoiconical in form, are marked, principally at the larger end, with specks of greyish-brown.

No. 33.—Petroica albifrons, Gml.
Totoara.
Robin.

Our rather dirty-looking Robin is one of the sweetest warblers of the bush, bold and confident, its habits may be easily observed, as one rambles near the rocky sides of a forest stream. Its nest is wider, and larger altogether, than that of *Petroica macrocephala*, but not so closely interwoven; moss, sprays, leaves, fine fibres, and grass, enter into its construction. Diameter of nest 5 to 6 inches, cavity 3 inches, with a depth of 1 inch 3 lines. A favourite

situation appears to be behind such protuberances as are to be found on the huge gnarled trunk of *Griselinia litoralis*, very often not more than three feet from the ground. Eggs, three or four in number, are dullish-white, with reddish marks, principally at the larger end.

No. 34.—Anthus Novæ Zelandiæ, Gml.
Pihoiboi.
Lark.

This well-known bird appears to be common all over the country; it builds on the ground, making its nest of grass, usually screened by a tussock. The eggs, five in number, are greyish-white, speckled over with dark-grey; sometimes a set of eggs may be noticed very much mottled over with brown, ovoiconical in form, measuring 10½ lines in length, by a breadth of 8 lines. We have an egg, very much smaller and darker than any others we have yet observed. In February, 1868, a pair made their nest within six inches of a shrubbery walk, and reared their young successfully, although so frequently disturbed,—the old bird invariably quitted the nest on its being approached. When a Harrier wheels round, and appears about to settle, Larks may often be observed, in numbers, gathering together with a chirping note, moving restlessly, sometimes with a short flight, watching and following the movements of their enemy.

Probably it is attempting to rid itself from the persecution of some parasitic vermin, when this bird is frequently observed to indulge in a dust-bath. It has a habit of keeping its insect prey in its beak for a long time, before it is devoured, or carried off to its nest. At last shearing time, two Larks, almost albinos, made their appearance, daily, about the yards of a wool-shed, on the Waikerukini.

Note.—In August, a nest was brought to the Wellington Museum, which contained several tufts of moss, but not neatly interwoven, like the workmanship of a bird that builds its nest principally of moss.

No. 35.—Zosterops lateralis, Lath.
Tauhou.
Blight-bird.

We first noticed this bird on some Fagus trees in the Rockwood Valley, Malvern Hills, July 28th, 1856. Its numbers, since then, have increased with great rapidity. It very soon obtained the name of the Blight-bird, in recognition of its services to gardens and orchards, from its habit of feeding on the American blight, with which apple trees in this colony are so generally infested; but, although the gardener noticed with satisfaction its labours in this direction, during the winter months, yet as summer returned and fruits ripened, its incessant depredations on cherries and plums were witnessed with anything but pleasure. From examining scores of nests, we find that out of a considerable variety of materials made use of, moss and grass predominate; the fabric is strong, although frequently slight, in some cases the walls are extremely thin; it is usually suspended, at the sides, by fastenings bound securely over slender twigs; some are almost wholly constructed of grass, amongst which, now and then, may be found a few small tufts of the grey-beard moss, in others the cottony down of plants is neatly interwoven with moss and spiders' webs, lined with fibres, or fine stems of grass, sometimes with hair; some nests are quite shallow, others of deep cup-like form (See Plate 5, Fig. 3), and measure in diameter 3 inches, cavity 1 inch 6 lines to 2 inches, depth 10 lines to 2 inches. In gardens, it has been observed placed in a great variety of shrubs, occasionally in a rose-bush bordering a well-frequented walk;

never far above the ground, usually from two to six feet. We have found it suspended to our common fern, *Pteris aquilina*. It lays three clear-blue eggs, ovoiconical in shape, measuring 8 lines in length, with a breadth of 6½ lines: incubation lasts about ten days. The nest and eggs form as pleasing an object as those of the Hedge-sparrow at home. The gift of song does not appear to be equally shared by these birds; in addition to the quick, sharp note or chirrup, which all seem to have in common, now and then an individual bird is heard pouring forth a low, well-sustained, melodious song; possibly the power may exist in all adult males, only to be indulged in at pairing time.

One of the pensile nest-builders, which seem to be almost equally rare in our temperate clime as they are in the old country. The suspension of its habitation is accomplished in a different manner from that of Gerygone, and more after the fashion adopted by *Regulus cristatus*, of Europe, the Kinglet or Golden-crested Wren, except that the nest is very often formed without any protection or shelter from an overhanging leaf. The rim of the ladle-shaped structure is firmly secured to a forked twig by silky threads of spiders' nests, finished on the outside, round the bottom, with braces of green leaves of grass, crossed and recrossed, which add much to the strength and stiffness of the fabric.

Now, as pensile nests are peculiarly adapted for ensuring the safety of their contents against the predatory attacks of various egg-robbers, does not the suspension of the habitation of the Zosterops,—the instinctive precaution of a foreign land (See *Chrysococcyx lucidus*),—afford an indication that it is a recent colonist, not yet so thoroughly acclimatized as to be fully aware of the immunity it enjoys from ravages of snakes, etc.? will that form of nest which is now sometimes found built *in*, rather than suspended *from*, a bush or thicket, become a more common object, and thus show a change in the style of architecture, as this bird, season after season, experiences the comparative safety of the breeding-places in our cooler latitude? Amongst our indigenous genera are there any pensile nest-builders? For years we invariably found three eggs to be the complement to a nest; now this last season we have met with several instances where four eggs have been laid, where this has occurred, the home has been built *in*, rather than fairly suspended *from*, a bush. If the reason, before suggested, for a modification in the manner of fixing the habitation be considered as not altogether too fanciful, may we not likewise be allowed to advance our opinion that the change of climate is also gradually producing its effects in the increased fecundity of our little Blight-bird.

Note.—Dec. 4—Nest in a manuka (*Leptospermum scoparium*), appeared to be completely lined and finished. On the 8th it contained three eggs; the next day a fourth egg was laid; on the 19th one callow nestling was exhibiting its ugliness, perfectly naked, except two or three small tufts of white down on the bald cranium, the body deep yellowish-pink, with dark slatey-coloured marks along the line of the vertebræ, the exterior of wing, and legs. The day following, his ugliness had a companion, on the 23rd feathers had made their appearance, where the slatey markings had been noticed; two unhatched eggs remained in the nest, which was only visited quietly once a day.

Young birds, for some time after they can fly well, can scarcely be said to possess any just pretension to the title of Zosterops, as they are without the circlet of white feathers round the eyes.

From the large number of nests we have observed, December must be the height of the breeding season.

The Zosterops is so partial to the berries of the trailing *Cotoneaster mycrophylla*, that we have known it to be taken by the hand, when it has been busily engaged on them; in the early spring we have observed it eating clover.

No. 37.—Rhipidura flabellifera, Gml.
Piwakawaka.
Fan-tail.

The pied Flycatcher seems to prefer proximity to water in selecting its nesting-place, we have noticed it most frequently near a creek, where overhanging boughs have afforded considerable shade.

The nest, beautifully made, is very compact, and, from our experience, varies very slightly in shape. The materials are well felted together, moss, grass-bents, fibrous roots, with cobwebs, etc.; the structure is fixed on some bough or spray, the foundation, very frequently, commences with chips of decayed wood. The prettiest nest we ever found, was on a leaf of the large silver tree-fern (*C. dealbata.*) (See Plate 4, Fig, 6.) The eggs, four in number, generally are white with brown freckles towards the larger end, 8 lines long, by 6 lines broad. We never found the nest very early in the spring.

Towards autumn this bird frequents the verandah, enters the house, clearing the rooms of flies, the snapping of the mandibles is plainly heard, as it flits circling round the room.

R. albiscapa, the fan-tail warbler of Tasmania, builds a nest with a long tail underneath, giving the whole structure a funnel-like appearance. Occasionally, *R. flabellifera* also builds its home with a long tail, but broader and less artistically finished than that of the *R. albiscapa.* One nest in our collection has this peculiar appendage, constructed of skeleton leaves and bents of grass, etc. What is its use?

No. 38.—Rhipidura fuliginosa, Sparrm.
Tiwaikawaka.
Black Fan-tail.

The Black Fan-tail Flycatcher breeds under conditions so very similar to those of the preceding species, that one description will serve for both. To our view, the most remarkable feature in the breeding habits of our Flycatchers is the situation usually selected for rearing their young. Security does not appear to be the first consideration; security, by concealment, seems the leading feature which guides most arboreal birds in choosing the site for their home, and it is one in which the most admirable displays of instinct may be frequently observed. The Flycatchers rather appear to be led by the same consideration which actuate many sea-birds in selecting the position of their breeding-place, proximity to the food supply. Stroll carefully along the rocky bed of a creek which rambles through some bushy gully, and you may perchance see the beautiful nest perched on some slender bough, in so delicate a manner, that it appears scarcely so much to be fixed, as to rest balanced there. There is no concealment amongst tangled creepers, guarded with their sharp recurved prickles; it is not buried amidst a mass of waving leaves, nor is it hidden away in the dim twilight of some hollow tree, but there, a few feet above the water, it sways gently with the subdued breeze, that reaches the quiet ravine through the leafy canopy that is spread around.

In thus placing its nest so obviously in view, one is reminded of its family connections, of the Spotted Flycatcher (*Muscicapa grisola*) of the old country, which we used to term the Post bird, from the almost glaring manner in which its unscreened habitation was displayed. But as "there is reason in the roasting of eggs," saith the proverb, so there is also instinct in selecting the place where they shall be laid; over the shady creek our Flycatcher is in the midst of sandflies, and the position chosen for its nest affords comparatively as good a vantage ground for supplying the wants of its young, as the nesting-place on the craggy mountain side bestows on the dashing Quail-hawk.

The Black and Pied Flycatchers breed together frequently.

NOTE.—Dec. 8th—Nest and eggs of *R. fuliginosa* fixed on a rock abutting on the creek in Valehead Bush, Malvern Hills; within a few feet, on the same rock, were two old nests.

No. 47.—PLATYCERCUS NOVÆ ZELANDIÆ, Sparrm.
Kakariki.
Parroquet.

As far as we are aware, the breeding habits of this variety of Platycercus differ in no material point from those of *P. auriceps*. We have been told that occasionally it breeds on rocks.

Eggs, oval in shape, measure 1 inch 1½ lines in length, by 10 lines in breadth.

This species is frequently to be seen caged; in confinement it imitates the human voice, with tolerable distinctness. This bird, as well as the smaller species, is frequently shot for food.

No. 50.—PLATYCERCUS AURICEPS, Kuhl.
Kakariki.
Parroquet.

The smaller Parroquet is a beautiful object, as with merry note it darts across the forest glade, with its bright green plumage glinting in the sunshine, giving at once a foreign impress to the scene, in the mind of the English settler.

Troglodytal in its breeding habits, it seeks some hollow tree or branch in which to rear its young; sometimes its nest is placed between the wood and the dissevered bark of a decaying tree; more frequently at the bottom of some deep hole. The eggs are white, and somewhat oval in shape.

In the gardens situated near bush, the Parroquet becomes a great purloiner of fruit. Near Arowhenua and Waimate, we have seen it rising in flocks from the oat-ricks. It is so bold as to be very easily snared with a tohetohe reed, noosed at the tapering point.

It commences breeding in August.

Since the great fall of snow, July, August, 1867, all bush-birds about the Malvern Hills appear to have become scarcer; for quite a year after that great storm, the silence in the bushes seemed quite remarkable, as though entirely deserted by their feathered songsters. This was notably the case in the Rockwood Bush.

No. 51.—NESTOR MERIDIONALIS, Gml.
Kaka.
Bush Parrot.

One of the commonest of our larger birds; yet in most of our bushes it is not nearly so numerous as it was a few years since. A troglodyte it may certainly be termed, for in the choice of a situation for its nesting-place, it seeks the shelter of a hollow tree. Sometimes the entrance-hole is a considerable distance from the nest, which is merely the decaying wood at the bottom of the hole. It lays four eggs, which, like those of most birds that breed in holes, are white; ovoiconical in form, they measure in length 1 inch 9 lines, by 1 inch 3½ lines. Sometimes, before the young are old enough to vacate the nest, it recommences laying. It is in considerable request as an article of food; they are fattest in the great Fagus forests, during the month of April. It is very easily snared, and readily tamed. The call of one bird in distress will soon cause it to be surrounded by numbers. A very common artifice is to hold a Kaka by the wing, its shrill call soon collects a crowd of its friends on the neighbouring

trees, where they soon fall to the gun of the pot-hunter. During a few weeks, in July and August, 1856, Kakas were to be seen in extraordinary numbers, they were poor in condition, perhaps tamed by hunger; they appeared to have lost their wonted vivacity, and numbers were cut over with stock-whips, as they sat perched on the rail fences, about stations on the Malvern Hills. The earliest bird in the bush, its call may be heard long before daylight.

No. 58.—Chrysococcyx lucidus, Gml.
Pipiwharaupa.
Bronze-winged Cuckoo, Whistler.

This beautiful little bird, in some districts, is most commonly known by the name of the Whistler. It is so called from its peculiarly clear note, which exactly resembles the sound made by a man whistling his dog.

It is remarkable for the regularity of its annual visits: in the neighbourhood of Christchurch it is almost sure to be heard about the 8th of October. We have a note of its appearing as early as the 27th of September (1855). The male bird usually selects the topmost sprays of the tallest trees for his perch, during the time it is giving utterance to its remarkable call; he seldom remains long in one spot, and indulges in a restless jerky motion of his tail. The female may be noticed very silently entering, and peering about scrubby bushes of no great height.

A parasite, like the Cuckoo of our Old Country, it saves itself all the trouble of nest-building by making use of the nests of other birds, and, of course, relieves itself of the care of providing for its young. Our experience points to the little Grey Warbler (*Gerygone assimilis*) as the most frequent victim of this "gay deceiver." The single exception we have ever observed, was the *Petroica macrocephala*, another insect-eating bird. We are not quite satisfied as to the manner in which the egg is deposited by a bird so disproportionate in size to the nest and its porch-like entrance, as that of the Gerygone. Either this Cuckoo does not destroy the eggs of the Warbler when it makes its deposit in the nest, or the bird lays to the egg of the intruder, as we have taken the nest with three of the Warbler's eggs, besides the egg of the Chrysococcyx; yet, whenever the young Cuckoo has been found in the nest, it has invariably been the sole tenant, we have not yet been able to observe in what manner the eggs, or young of the rightful owners have been extruded. In selecting the nest of so early a breeder as the Grey Warbler, as a home for its young, it secures certain advantages for the benefit of its offspring which should not be lost sight of. At the period of the Cuckoo's arrival the Warbler has most probably reared its first brood, so that even young birds have had time to gain experience in building their habitation and rearing their nestlings; then too, everywhere insect life abounds, so that a proper supply of food, sufficient for comparatively so large a bird, can be obtained by its little foster parents, with less labour and more certainty, than it could have been secured two months earlier, when several birds commence their breeding arrangements. It has been noticed, under Gerygone, why the domed nest is selected, namely, for its warmth. Then, in addition, the Golden-winged Cuckoo, be it remembered, has a most extensive range, even to the tropical islands of New Guinea, Java, and Sumatra—according to Schlegel—(see "Finsch's Notes," p. 118), and it probably chooses a pensile nest, through the same instinct, a regard to the safety of its young, which causes the *lately*-settled Zosterops to continue, for the *present*, a pensile nest-builder, though, as we have said elsewhere, we think there are indications of a change in its style of architecture. The selection, made by this Cuckoo, goes to strengthen our idea of the non-indigenous origin of our pensile-nest-builders. The egg, elliptical in form, pale greenish-dun in colour, measures 9 lines in

length, with a breadth of nearly 6 lines. Locality, slopes with manuka scrub, in Ohinitahi, Governor's Bay. The Whistler is a great insect eater, and appears especially fond of the well-known ladybird; we are not without certain suspicions that it devours or destroys the eggs of other birds.

No. 60.—Coturnix Novæ Zelandiæ, Quoy.
Koreka.
Quail.

This excellent game bird is almost extinct, but a few years since it existed in the utmost abundance; bush fires, extending often for many miles, must have been the active agent in destroying a bird possessing such limited powers of flight, as our handsome little Quail.

A very slight nest, composed of a few bents of grass twisted into a depression of the ground, was all the artificial shelter this bird relied on, for the purpose of incubation. The eggs were very numerous; we have been told that as many as ten or twelve have been found in a nest, oval in shape, colour buffy-white suffused with rich brown splashes, with a remarkably glossy varnish; length 1 inch 3 lines, by 11 lines in diameter. We have not heard its call-note, or seen a bevy of Quail, for years. The sheltered valleys round Lake Coleridge, and about the head-waters of the Rakaia, were the last places in which it lingered, to our knowledge. They bred more than once in the season, as we have a note of abundance of young Quail so late as the 9th and 10th of April (this was in 1857). We have seen it escape the talons of the Quail-hawk, by dropping perpendicularly, just when about to be struck, when all hope of escape from its relentless pursuer was quite abandoned. The flight of the Quail is low, and it used to be said that it would not rise after being flushed the third time: numbers were killed by sheep and cattle-dogs in the early days, when it abounded. In style of flight, our bird must resemble the Quail of Taberah and Kibroth-hattaavah, that fed the Children of Israel, in the wilderness:—"And there went forth a wind from the Lord and brought quails from the sea, and let them fall by the camp, as it were a day's journey on this side, and as it were a day's journey on the other side, round about the camp, and as it were *two cubits high* upon the face of the earth." Our bird is not migratory as we believe. The young, with the exception, perhaps, of that of *Apteryx Owenii*, undergoes less change in plumage than that of any other bird; the young, when it assumes its feathers, exactly resembles the adult female, with the white streak along the shaft of the feathers, which adds so much to its beauty.

No. 61.—Apteryx australis.
Kiwi.

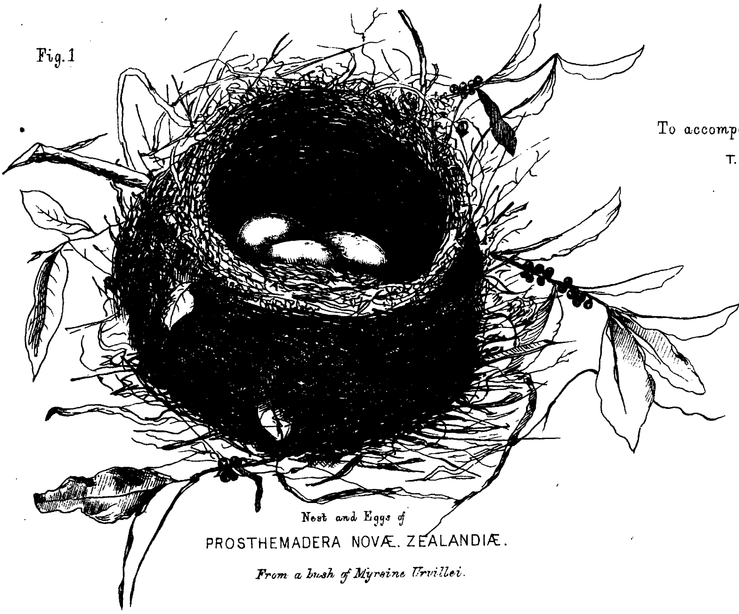
We have not enjoyed an opportunity of acquiring, from personal observation, any knowledge of the breeding-habits of the curious family of Apterygidæ: a description of the eggs of the different species may be thought not out of place in the present paper. We believe this species is peculiar to the Middle Island.

An egg received at the Canterbury Museum from Okarito, or its neighbourhood, is believed to be an undoubted specimen of this species,—it arrived, in a fresh state, in November. It was white, much blunted at each end, and presenting a very smooth surface; this enormous egg gives the following measurements: through the axis 5 inches 1 line, with a breadth of 3 inches 4 lines.

Rev. J. G. Wood, in his "Nat. Hist. Birds," writes of the eggs laid by the Kiwi at the Zoological Gardens, London: "These eggs are indeed wonderful, for the bird weighs just a little more than four pounds, and each egg weighs between

Fig. 1

To accompany Paper by
T. H. POTTS.

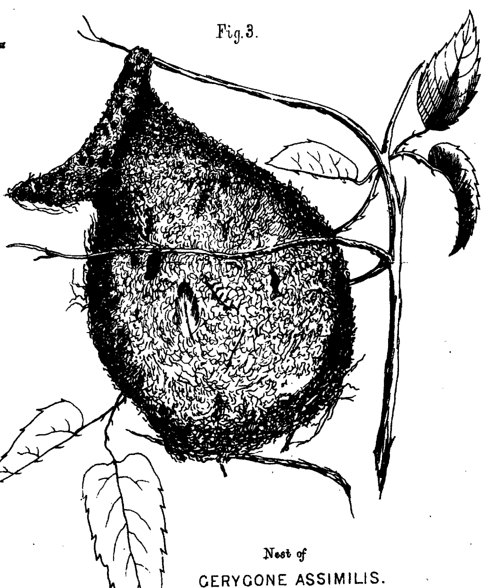


Nest and Eggs of
PROSTHEMADERA NOVÆ. ZEALANDIÆ.
From a bush of Myrsine Urvillei.

Fig. 2.

Nest of
CERYGONE ASSIMILIS.
From the fork of a willow tree.

Fig. 3.



Nest of
CERYGONE ASSIMILIS.
Front and Porch ornamented with burrs of Acæna. (side view.)

T. H. Potts. del. J. B. lith.

Printed at the Gen. Gov. Lith. Press by J. Earle.

fourteen and fifteen ounces; its length being 4¾ inches, and its width rather more than 2 inches."

The Canterbury Museum also contains some fine specimens of the bird, obtained from Westland.

No. 62.—Apteryx Owenii.
Kiwi.

The smallest and most common of the whole family. Specimens of Owen's Apteryx are not very rare in collections, but the celebrity which attaches to this wingless genus is rapidly drawing down destruction upon it. No mercy is shown to it, and there is no exaggeration in stating that a regular trade is carried on in specimens of these birds, and the equally unfortunate Kakapo (*Strigops habroptilus*). Could not our paternal Government interfere in behalf of these interesting aborigines, for we believe there are those who would shoot the Cherubim for specimens, without the slightest remorse. This species is peculiar to the Middle Island.

An egg in the Canterbury Museum, from the West Coast, measures 4 inches 6 lines in length, with a breadth of 2 inches 7 lines (other specimens we have measured are of rather larger dimensions); colour, white, with a very smooth surface, blunt at each end.

The young of the Kiwi, without exhibiting any sign of an immature state of plumage, is disclosed, as it were, from the shell, arrayed in the hair-like integument of an adult bird. In this species the mottled-grey feathers of old and young appear to be of same shade of colour.

No. 63.—Apteryx Mantellii.
Kiwi.

This is usually known as the Kiwi of the North Island, and it is believed that it has become comparatively rare during the last few years.

An egg, in our own collection, from Whangaroa, measures not less than 5 inches 4 lines in length, with a breadth of 3 inches 3 lines. This specimen is white, of smooth surface, rather more pointed at one end than is usually the case with the eggs of this family.

No. 65.—Charadrius bicinctus.
Banded Dotterel.

The family of the Charadriæ have always been distinguished for their wariness, and the artful devices employed to allure strangers from their nest. Heliodorus gives such a singular reason for its shyness, that we cannot resist quoting it: "The bird Charadrius cures those who are afflicted with the jaundice. If it perceives, at a distance, any one coming towards it, who labours under this distemper, it immediately runs away, and shuts its eyes; not out of an envious refusal of its assistance, as some suppose, but because it knows by instinct, that, on the view of the afflicted person, the disorder will pass from him to itself, and therefore it is solicitous to avoid encountering his eyes." Our banded Dotterel is worthy of belonging to the family of the Charadriæ, for it is one of the most restless and wariest of birds, during the breeding season. On the approach of an intruder, it flies round and round, uttering its note of warning, then alighting on some rising ground, it steadily keeps watch. During the time it remains on the look out, it indulges in a peculiar habit of jerking its head backwards and forwards, uttering its monotonous twit, twit, at intervals.

It commences breeding early in the spring; its simple nesting-place may be found on "the plains," or in river beds. It lays three oval-shaped eggs,

greenish-brown, much sprinkled with dark-brown markings; they measure 1 inch 4 lines in length, with a breadth of 1 inch.

The young are exceedingly active, the little brown puffs of down may be observed running with great swiftness on being alarmed. In the autumn the Dotterel assembles in flocks of considerable numbers.

NOTES.—August 2, 1856, saw a nest and two eggs, Rakaia river.
September 1, 1856, saw nest and three eggs, Rakaia river.
October 14, 1857, young birds quite strong.

No. A. 65.—CHARADRIUS OBSCURUS, Gml.
Tituriwhatu-pukunui.
Red-breasted Plover.

In Dr. Finsch's list, in Vol. i., "Transactions New Zealand Institute," this Plover is named *Hœmatopus obscurus.*

This handsome bird is to be met with on hill and plain, yet nowhere in very considerable numbers. In the breeding season we have noticed it at such a considerable altitude as the summit of Dog Range, in the Ashburton district. The nest is difficult to find, it is so slight an affair that it easily escapes observation, merely a few stems of grass twisted into a slight hollow in the ground, so loosely put together that it is not easy to pick it up and yet preserve its form. The eggs, three in number, just fill the nest; they are of a delicate soft-brown, suffused with dark-brown, almost black, marks, somewhat oval in shape, in length 1 inch 9 lines, with a breadth of 1 inch 3 lines. The young run with speed almost as soon as hatched, and conceal themselves with much skill. Young birds have not the rufous tinge on the breast and upper part of the abdomen. We have observed eggs and young in the months of October and November.

NOTE.—Oct. 22, 1867—Nest with three eggs;—saw young Plovers.

The warning-note of this bird sounds like click, click, slowly repeated.

An excellent figure of it, rather warmly coloured, is to be found in Ross's "Voyage of the Erebus and Terror," Vol. i., plate 9, Birds.

No. B. 65.—ANARHYNCHUS FRONTALIS, Quoy. and Gaim.
Scissor-bill,
Crook-billed Plover,

Appears in Dr. Finsch's list, "Transactions New Zealand Institute," Vol. i., as *Hœmatopus frontalis.*

The Crook-billed Plover, at the breeding season, is less wary than any of its congeners, and its nesting-place would be discovered with very little difficulty, were it not for the wonderful instinct it exhibits in selecting the ground for depositing its eggs. They are simply laid, without any preparation, amongst the pebbles of some river-bed usually, and never far from water, and so well does their grey tint harmonize with the general colour of the shingle around them, that their detection would be almost hopeless if this bird was less confident.

Its oval-shaped eggs are three in number, grey stone-colour, with the whole surface minutely dotted over with black specks; they measure 1 inch 4½ lines in length, with a width of 1 inch ½ line. On approaching the eggs or young, the old bird trots slowly away, assuming a broader and somewhat flatter appearance, by slightly extending the wings, making at the same time a low purring sound.

Breeding season extends from September to December.

The young birds are covered with grey down, and appear to have legs long, out of all proportion to the size of the body; at this early stage, the peculiar deflection of the bill, although slight, is perceptible; it is always

turned to the right, or off side. Birds of the year, we believe, do not assume the frontlet which distinguishes the old birds, and which is broadest in the male. No satisfactory reason has been given for the peculiar form of the bill of this bird, which exceeds in length that of *C. bicinctus*.

NOTES.—Sept. 14, 1856—Saw three eggs on a patch of small shingle.
Oct. 28, 1857—Young birds on the Rakaia river-bed.
Oct. 30, 1867—Two eggs on the bare shingle, Rakaia river.
Nov. 2, 1867—Three eggs chipped, on shingle, Ashburton river.

No. 71.—HÆMATOPUS LONGIROSTRIS, Vieil.
Torea.
Oyster-catcher, Red-bill.

The Oyster-catcher is one of the wariest and most restless of our birds, ever ready with its clamorous alarm-note, to wake up each echo, and disturb every bird within the sound of its shrill cry; but in the breeding-season it exhibits an intensity of slyness, that is almost supernatural. Usually it breeds in our river-beds, on the sandy spits, without other shelter than what may be afforded by some drift flax, grass, or stick, near which it makes, or discovers, a slight depression, in which to deposit its eggs, which are somewhat oval in shape, 2 inches 3 lines in length, with a diameter of 1 inch 7½ lines; pale or yellowish-brown; these are not to be distinguished from those of the European bird, much covered with irregular marks and spots of rich brown. Usually three eggs are laid, but we have found it incubating a single egg: the young are grey, with a dark longitudinal stripe on each side, above the wing. They are very active, and are early led by the old birds to the margin of the water-holes or pools. On being alarmed, the old bird sidles off the nest quietly, takes advantage of any broken ground that apparently conceals its movements from observation, and makes a long detour; a close scrutiny will very frequently enable the observer to detect the head of the bird carefully peering out behind some vantage-ground, watching all his proceedings.

A very common frequenter of the coast, as its familiar name imports; in the winter time it assembles in large flocks on the mud flats disclosed by the ebbing tide; though a shore-bird, it is found breeding in solitary couples, often far inland, certainly sixty or seventy miles from the sea, for instance, up the Wilberforce river, nearly as far back as the neighbourhood of Browning's Pass. A pair will boldly attack the Harrier, male and female striking at the Hawk in turn, and driving it to a safe distance from their young. Hæmatopus, that is, literally, the blood-red foot, one of the birds mentioned by Pliny, appears to be universally met with.

No. 75.—BOTAURUS POICILOPTERUS, Wagl.
Matukuhurepo.
Bittern.

Not so frequently met with as before such an extensive breadth of swamp-land had been drained and cultivated. It was once very common about Christchurch, "the City of the Plains," it still haunts the banks of the Avon, and breeds in the neighbouring swamps. The breeding season of the Bittern must extend over a considerable period, as we have found the eggs, quite fresh, in the middle of January (15th). A nest near Clearwater, or Lake Tripp, in the Ashburton country, was built of raupo, (*Typha angustifolia*), surrounded by water about ankle deep; the top of the nest was very flat, and stood about six inches above the surface of the water. (See Plate 4, Fig. 7.) We have not seen more than four eggs to a nest, they are oval in form, varying slightly in colour, from buffy-brown to pale olive-green. Through the axis they measure 2 inches 1½ lines, with a diameter of 1 inch 6 lines.

No. 78.—HIMANTOPUS NOVÆ ZELANDIÆ, Gould.
Poaka.
Pied Stilt.

Usually commences breeding in October, according to our experience. Unlike the black variety, we have always found this bird prefers swampy ground, such as fringes the shores of shallow lagoons, as a nesting-place, etc. Here it may be observed busily wading in the shallow water. In its habits of nidification, it is as inartificial as its congener. Eggs, four in number, yellowish-brown in colour, about the same size as those of the Black Stilt, are profusely marked with very dark brown; we have thought the eggs rather warmer in colour than those of the black variety. The monotonous call of pink, pink, has, in some places, fixed on it the trivial name of Pink.

No. B. 78.—HIMANTOPUS MELAS, Homb. et Jacq., "Ann. des Sci. Nat., 1841."
Black Stilt.

Breeds early in the season, seeking the sandy river-beds for that purpose. The labour of nidification is very trifling, sometimes a nest of grass, etc., is roughly constructed, now and then this apology for a nest may be discovered on a log of drift-wood; much more frequently, however, a slight depression in the sandy spit, answers all the requirements of this Stilt, as a nesting-place; it is never very far from water.

It lays from three to four eggs, rather oval in shape, yellowish-brown in colour, very much spotted and blotched over with very dark-brown, approaching to black, measuring 1 inch 10 lines in length, by 1 inch 3 lines in breadth. The young can run almost as soon as they are hatched; when disturbed, they conceal themselves behind stones, or some other shelter, in the most artful manner; they are covered with dark-brown down, bills and legs are then very dark, almost black. The parent birds exhibit the utmost assiduity in attempting to lead intruders from their eggs or young, and their numerous cunning devices are carried on with surprising cleverness and perseverance.

We have been told that there is not a Black Stilt, that the Black Stilt, so called, is, in reality, but the pied species in an immature state of plumage. To this we cannot for a moment subscribe, we have never once found the two species breeding together or using the same, or even similar situations, for their nesting-place.

Neither Mr. Buller nor Dr. Finsch, we remark, admit this bird in their lists, but, with the utmost deference to those authorities, we cannot consent to give up such an old acquaintance as the Black Stilt. Our opinion on this subject, is shared in by many others, living "up country," who have had good opportunities, for several years, of observing the breeding habits, and the young birds of both species of Stilts.

NOTES.—Sept. 13—Nest with three eggs, on a spit on Rakaia river-bed.
Dec. 14—Nest with two eggs, on a drift-log in the Rakaia river-bed.

No. 87.—OCYDROMUS AUSTRALIS, Sparrm.
Weka.
Wood-hen.

This bird is so mischievous to the fruit garden and poultry-yard of the up-country settler, that unrelenting war is usually waged against it. Small fruit, low-growing apples, eggs, and young chickens, form some of the items of its favourite plunder; nor is its thieving propensities confined to articles of food, spoons, pipes, pannikins, and a long list of miscellaneous articles, we have known this *curious collector* to carry off. On one occasion, in Alford Forest,

a watch was stolen, and accidentally recovered, a few days after, at some little distance from the hut; for the Weka, unlike the Jackdaw at home, does not appear to care for a secret hiding-place in which to conceal its pilferings.

We have seen it kill a well-grown Spanish chicken, six weeks old, with one blow of its powerful bill. Some time since, a Weka appeared in our garden, much to our gratification, for, in the neighbourhood, the bird was of very rare occurrence; all went well till the first brood of choice Dorking chickens was discovered, and then, well, the Weka had to die.

At night, and before rain, the loud screaming of this bird is most frequently heard. The nest is found in a variety of situations, such as in a tuft of Celmisia, grass-tussock, or sometimes in a thicket of young plants, on the outskirts of the bush; we have observed it under the shelter of a rock, without any attempt at concealment, which the tussocks growing close by would have afforded. Grass is usually the staple material of its home, which is large, and basin-shaped within. The eggs, from five to seven in number, are white, with reddish marks generally distributed over the surface; but in many specimens the colouring is most abundant at the larger end. The young, covered with very dark down, may be observed, like chickens, following the old bird, who collects them around with the call of toom, toom, repeated quickly, and much lower in tone than the booming note to which the Weka sometimes gives utterance, and which is probably the call of the male. As the young grow up, the dark-brown of its early days gives place to a more mottled plumage when about one-third grown; although the legs become lighter in colour, the beak still retains its dark appearance. There is much difference in the size of Wekas, some of the hill-birds are very large, and we expect that before very long they will be classed as a separate species.

A very light-coloured specimen was observed near Mount Hutt, last year. Numbers of these birds are killed for their oil, which is much esteemed by bush-men for a variety of purposes; properly dressed, they are excellent as an article of food, due care being taken as to where they are obtained, as they are very foul feeders.

No. 91.—Porphyrio melanotus, Temm.
Pukeko.
Swamp-hen.

This beautiful rail delights in swamps, where its nest is also to be found, built of grass; the top is sometimes more than a foot above the ground, and not unfrequently it may be observed surrounded by water. The number of eggs to a nest varies considerably, as we have found from two to seven, five may be considered the usual complement, in shape ovoiconical, greyish-brown, with dots and blotches of reddish-brown, measuring through the axis 2 inches 2 lines, with a diameter of 1 inch 6 lines. These dimensions appear very small for so large a bird, more especially when compared with those of the egg of *Apteryx Mantelli*. The young run about as soon as they are hatched, and on being disturbed conceal themselves with great art. They are thickly clothed with black velvety down, interspersed with fine hair-like points of silver-grey; legs dullish-red, beak has a yellowish ivory look, which contrasts pleasingly with the rest of the body. The Pukeko is esteemed excellent eating.

No. 92.—Casarca variegata, Gml.
Putangitangi.
Paradise Duck.

This well-known bird often chooses the shelter of a huge tussock, beneath which to make its nest; sometimes a hole in a rock is chosen in preference.

We know a large rock, on the bank of the Rakaia, where a pair of these birds breed every year.

The nest is warmly lined with down; nine eggs are sometimes found in a nest, but not often have we noticed so large a number; they are large, creamy-white, ovoiconical, vary somewhat in size, even in the same nest; length 2 inches 9 lines, with a diameter of 1 inch 10 lines. The Paradise Duck leads its brood to water very soon after hatching. The parent birds may be noticed surrounded by their tiny young ones, spending nearly the whole day upon the water, even when the usually smooth surface of the lake has been lashed into foam-crested waves by a furious Nor'-wester. They enter the lake after the sun is well up, and remain till late in the afternoon; this is daily repeated, the young birds gradually venturing farther from the old ones, and may be observed darting about with the greatest activity.

This bird employs the wiliest stratagems to lead the wayfarer from its nest or young.

NOTES.—October 24, 1855, noticed nest with eight eggs, Malvern Hills.
November 1, 1867, saw nest with five eggs, another with six eggs, on the Potts river.
December 2, 1867, Duck sitting on five eggs, Rangitata river.

The congress of the sexes takes place in water, after the manner of the common Goose. When young, the flesh of the Paradise Duck is very good eating, but in old birds there is a degree of toughness, that only the sharpest appetite can overcome.

The young are easily tamed, and feed amicably with other poultry; but unless confined when spring sets in, they are almost certain to ramble away and be lost.

No. 93.—ANAS SUPERCILIOSA, Gml.
Parera.
Grey Duck.

One of the commonest game-birds left to us by the eager sportsman. We have found the nest of the Grey Duck in so many situations, differing so entirely in character, that it would be difficult to pronounce any one position as the favourite site for its breeding-place. Sometimes close by the edge of a bush creek, amongst damp shady ferns; out on the plain, sheltered by a tussock, quite away from water; often on a hill side. Yet, whether on the level plain or in a swamp, its cup-shaped nest is most profusely lined with down, and diffuses a strong musky odour. The eggs, usually nine in number, are creamy-white, occasionally varying a little in size and shape, some are ovoiconical, others broadly oval; 2 inches 6 lines through the axis, with a diameter of 1 inch $8\frac{1}{2}$ lines, is the measurement of a large specimen; whilst we possess specimens that measure but 2 inches 3 lines in length, with a diameter of 1 inch 7 lines. On referring to many notes on the numbers of eggs laid by the Grey Duck, an entry appears of ten eggs in a nest, found December 10th, near a lagoon by the Rangitata, the largest number of which we have a memorandum. We have seen the young quite tame, and associating with the common domestic Duck.

No. 94.—ANAS CHLOROTIS, Gray.
Puteke.
Teal.

Very much scarcer of late years than we can remember it. A few years ago we used to hear tales of almost incredible bags of this excellent game-bird; a few more years of inconsiderate slaughter, will make the Teal a rarity.

The nest is made of grass, thickly lined with down, sometimes close to the edge of a swampy creek, or beneath the sheltering leaves of a large "Maori-head" (*Carex virgata*).

The eggs are large, for the size of the bird, cream colour, not unlike those of the Mountain Duck, in tint, but perhaps slightly darker; length 2 inches 5 lines, diameter 1 inch 10 lines, We have not found more than eight eggs to a nest. On a pond at Rockwood, in the Malvern Hills, three Teal fraternised with some tame Paradise Ducks, and came regularly, to be fed, every day, with pieces of bread.

No. 96.—Fuligula Novæ Zelandiæ, Gml.
Papango.
Black Widgeon.

In the hill-country, a few years since, this was sufficiently common; a small tarn, near Lake Coleridge, yet retains the name of Widgeon Lake, from the numbers which formerly frequented it. Near one small pool in the Ashburton country, where it bred in considerable numbers, neither birds nor nests are now to be met with.

A gregarious bird, it delights to assemble in large flocks, and may be seen on some of the more secluded lakes, swimming about, and disporting with numbers of other water-fowl, very frequently diving. Sometimes it breeds in the shelter of a huge "Maori-head." We have found it well concealed by a large snow-grass tussock, within a few feet of water, where there was a rent or crack in the ground. Nest of grass, thickly lined with down, contained five eggs of a deep cream-colour, ovoiconical in form, measuring 2 inches 8 lines, with a diameter of 1 inch nearly 9 lines.

No. 98.—Hymenolaimus malacorhynchus, Gml.
Whio.
Blue Duck, Mountain Duck.

The only way of seeing this singular bird to advantage, is by paying a visit to the mountainous districts. On a mountain torrent, where the foaming water dashes from rock to rock in countless eddies, the Mountain Duck lives at ease, making its way up or down stream. Sometimes it may be observed basking in the sunshine, near a shallow pool of the rapid streamlet. Sometimes it is a burrower, and its nest may be found in a hole in a bank; we have found it concealed from view by overhanging sprays of those various alpine Veronicas, which sometimes make the mountain creeks in the back-country perfect gems of beauty. The nest, like that of other ducks, thickly lined with down, we have found to contain five eggs, of a deep-cream colour, elliptical in form, measuring 2 inches 8½ lines in length, with a diameter of 1 inch 9 lines.

One of our early breeders; we have known the young brood to be swimming about by the end of September. We have seen nests of eggs in October and November. A much frequented breeding-place is above the gorge of the Potts river,—a tributary of the Rangitata.

No. 99.—Podiceps rufipectus, Gray.
Totokipio.
Dab-chick, Little Grebe.

This bird is far from uncommon, and is to be met with on lakes, lagoons, and deep creeks that run still and swift, unlike the noisy torrents in which the Mountain Duck delights.

The nest is rather a large and somewhat clumsy structure, formed of the roots and leaves of various aquatic plants. We have found it built against

the stem of the *Carex virgata*, beneath the drooping leaves of which it was perfectly concealed from casual observation. Situated just within the swampy side of a small lake, it was raised a few inches, only, above the water-level. We have invariably found two eggs to a nest; they are greenish-white, frequently with wart-like protuberances, and more or less weed-stained.

Eggs from the same nest occasionally differ a little in size, as may be observed from the following measurements: length 1 inch 9 lines, by a diameter of 1 inch; whilst another egg, from the same nest, measured in length 1 inch 6½ lines, with the same diameter as in the longer specimen. The lobed foot of the Grebe is a remarkable peculiarity, assisting it to swim and dive with great rapidity; in its habits it appears much more restless and fidgetty than the large Crested Grebe. The young is greyish-brown on the back, warm-rufous on the neck and breast, lighter on the abdomen; the head is beautifully mottled with black, and rich reddish-brown alternately. When alarmed on the water the parent birds have a knack of tucking the young under the wing, so that its head is alone visible; they dive and swim, thus encumbered, with the greatest ease.

No. 100.—Podiceps Hectori, Buller.
Crested Grebe.

One of the most ornamental of the water-fowl, that add so much to the interest of the lake scenery of our Southern Alps. In April, 1856, we first made its acquaintance, on a small lake, now called Lake Selfe. It appears to move about in pairs, as a single couple is usually found (or rather was to be found) associating with nearly every group of Ducks that dotted the little secluded bays of the lakes.

The Grebe swims low in the water, with a certain air of demure gravity, which affords a marked contrast to the rapid movements of most of the other natatorial birds, with which it so frequently associates.

We have found the nest in November and December. The structure is large, and very solidly built of pieces of decayed *Carex virgata*, raised about a foot above the level of the water; its sloping sides give a ready means of reaching the basin-like depression on the top, in which the eggs are deposited. (See Plate 4, Fig. 5.) In several instances we have observed that the nest had been constructed on the top of an old stump of *Carex virgata*, situated in a shallow part of a lake, distant from twenty to one hundred yards from the shore. Last Spring, in the little boat-harbour on Lake Coleridge, belonging to Mr. Oakden, there happened to have been thrown a quantity of cut flax, which the bight of a chain prevented from drifting out to the lake; a pair of Crested Grebes built on this floating mass, and succeeded in rearing their young; it should be added, this harbour is not much used, and the proprietor is a careful protector of our native birds. We have known three instances, in which the nests have been submerged by the rising waters of the lake, an indication that such mishaps must frequently occur, which may perhaps in some measure account for the comparative rareness of this Grebe.

The eggs, three in number, are at first greenish-white, but very quickly become stained over, entirely, with yellowish-brown, from the water and weedy slime adhering to this bird's flat lobed foot. Eggs elliptical in form, measuring through the axis 2 inches 4 lines, with a breadth of 1 inch and nearly 7 lines. We believe that an interval of two, perhaps three, days occurs between the laying of each egg. The young bird is pale-brown with dark brown marks. During incubation the Grebe maintains an upright posture, with its long graceful neck held erect, so motionless its attitude, that at a distance it rather resembles a stick than anything endued with life. Watchful and shy, it noiselessly dives, immediately it discovers itself observed. The

power of diving, and the faculty of remaining under water for a considerable time, is too remarkable a characteristic of this bird to be passed over without notice.

No. 104.—Spheniscus minor, Forst.
Korora.
Small Penguin.

One of our commonest sea-fowl; and certainly a frequent burrower in its mode of nidification.

We have found the Penguin breeding every year, in the inner chamber of a deep cave, perfectly dark; a hollow, scraped out of the sandy bottom of the cavern, half filled with fish bones, formed the nesting-place, in which the eggs were deposited. We have always found two eggs, as the complement of the Little Penguin.

The eggs are white and very smooth, but soon become stained; they are broadly oval, and measure, through the axis, 2 inches 2 lines, with a diameter of 1 inch 9 lines. The old birds defend their nests with great spirit, using beak and claws most vigorously, making at the same time a noise not unlike the mewing of a cat.

We have observed these birds breeding during the months of November, December, and January. They breed in great numbers amongst crevices of rocks; in sand-banks, their tunnels are bored with great neatness, with a run frequently extending a considerable distance. The entrance generally exhibits a perfectly round hole, about three or four inches in diameter, and from whence is diffused a most powerful odour. The young, we have found in the nest when nearly full-grown; their slatey-bluish plumage is brighter than that of the parent birds. We have an egg, very much encrusted, showing a departure from their usual appearance, which is usually as white and smooth as that of the domestic fowl. In retreating to the sea, its action is peculiar, walking it can scarce be called, it appears to throw the whole body forward, and shuffles along with an undulating motion, which gives the Penguin more the appearance of a large grey rat than that of a bird.

No. 126.—Larus dominicanus, Licht.
Kororo.
Grey Gull, Black-backed Gull, Large Gull.

Our larger Gull breeds on the sea-shore, upon the sandy spits in the river-beds. The rough-looking nest is large, usually made of grass, sometimes of small tussocks pulled up by the roots. We have noticed these birds visiting the breeding-ground early in August, but have not seen the eggs till some weeks later, apparently these must have been visits of inspection, when they busied themselves about the nests in rather a clamorous manner for several days in succession. The eggs, two or three to a nest, are ovoiconical, measuring 2 inches 10 lines in length, by 1 inch 10 lines in width. The colour varies from shades of light-grey to brown, covered, more or less, with grey and brown marks and blotches. The young are well covered with grey down at first, they assume, gradually, a mottled-brown plumage, the bill still dark, presenting a marked contrast to adult birds. The parent birds defend their nest with great spirit, a pair will drive away, and give chase to, a Harrier. Their olfactory organ must be most acute, as they find out the carcase of a dead sheep or bullock with great readiness.

We have often been amused by watching their grotesque action in following a retreating wave, where the sea has rolled in heavily on the inclined sandy beach. A number of these Gulls wait till the wave has just expended

its force and follow the retreating waters rapidly, by a series of hopping jumps, feeding the while, and sometimes only just avoiding the next incoming wave, by taking wing for a few yards with apparent reluctance.

No. 127.—Larus scopulinus, Forst.
Tara-punga.
Little Gull.

During the breeding season, our very pretty Little Gull frequents the river-beds, and shores of lakes, in very large numbers. It deposits its eggs with scarcely any of the preparation that distinguishes the larger species of Gull. The eggs are usually found on the bare ground; at most a few bents of grass, amongst the stones, sufficing for a nest. The eggs, often broadly oval, sometimes ovoiconical, are of different shades of greyish-brown, plentifully besprinkled with darker marks and blotches of grey and brown. Length, 2 inches 1 line, by a diameter of 1 inch 6 lines.

No. 129.—Sterna caspia, Pall.
Fish-hawk.

This fine Tern is content with merely a hollow scraped in the sand, just large enough to contain the eggs; the breeding season extending from November to January; our earliest note of having seen the egg, is dated November 14th.

The eggs, usually two or three in number, ovoiconical in form, measure 2 inches 7 lines in length, with a diameter of 1 inch 9 lines; we have a specimen from Lake Ellesmere, much smaller than is shown by this measurement; the eggs are of varying shades of pale greyish-brown, richly spotted with dark-grey and brown, distributed all over the surface; in some specimens these markings are most numerous at the larger end. When these birds are disturbed at breeding-time, they ascend to a great height, and hover around the intruder, uttering loud screams. We have found the young as large as the adult *Larus scopulinus*, before they were able to fly. Have found this bird incubating a single egg.

No. 130.—Sterna longipennis, Nordm.
Whale-bird.

The black-billed, swallow-tailed Whale-bird seems constantly to frequent our coasts and harbours, the liveliness of its movements on the wing, especially the rapidity with which it drops from a great height to secure its finny prey, frequently renders it an object of remark to the dwellers on the sea-shore, it deposits its egg on the bare rock, without the slightest protection, at a distance varying from about five to six feet and upwards from the level of high tide; the egg must often lie within reach of heavy showers of spray. Ovoiconical in form, generally, but sometimes rather oval, the egg measures 1 inch 10 lines in length, with a diameter of 1 inch 4 lines. Colour varies from shades of pale-grey, sea-green, stone-colour, or light-brown, lightly freckled with brown, or profusely blotched with slatey-grey, and chesnut-brown, to almost black. The young covered with mottled-grey down, varying in shade to almost brown, are quite helpless for two or three weeks after hatching, and appear quite unable to attempt securing safety by swimming, like young Gulls, when alarmed; they retain the grey feathers on the head even when well-grown. Great quantities of small fish may usually be noticed surrounding the young birds. We believe this bird lays but one egg, but are aware that others entertain a different opinion. On a rocky point, in Port Cooper, which is

washed with abundant showers of spray under a strong N.E. breeze, we observed about 200 birds breeding; except in three cases only, the eggs were solitary.

NOTE.—Dec. 14—Found two eggs lying together, differing in size and colour so much, that there is not much doubt they were the produce of different birds.

No. 131.—STERNA ANTARCTICA, Forst. Common Tern.

In this paper on our Birds, the nomenclature followed is that which is given in Dr. Otto Finsch's Notes, "Trans. New Zealand Institute," Vol. i., pp. 122-5, but in the case of this bird we prefer adhering to the name assigned to it by Forster. In a note in the volume referred to, page 121, *S. antarctica*, Forst., is asserted to be the same species as *S. minuta*, Linn. Mr. Buller, in his "Notes on Herr Finsch's Review," tacitly admits this by his silence; we think this must be an error. Yarrell, in his "History of British Birds," Vol. iii., p. 525, writes of *S. minuta*, "their eggs are of a stone-colour, spotted and speckled with ash-grey and dark chesnut-brown, the length 1 *inch 4 lines, by* 11 *lines in breadth.*" This measurement is exactly the size of the eggs of the next species, which we have numbered A. 131, whereas the eggs of the yellow-billed *S. antarctica* measure in length 1 inch 6 lines, by a breadth of 1 inch 1½ lines, and present a very striking contrast in colour; they differ also in shape. On referring to our collections of British and New Zealand eggs, and comparing the eggs of these species of Terns, any hesitation we may have entertained about the correctness of adhering to Forster, instead of the more modern authorities, is removed. The Common Tern, very often termed the Whale-bird, seems even more gregarious than its congener *S. longipennis*, that is, taking into consideration its habits throughout the year. It may be observed hovering over the newly-ploughed fields in great numbers, in search of larvæ of various insects; the small lizard seems a favourite morsel, and may frequently be noticed dangling from the beak of this Tern.

We have remarked, several times, a curious habit of this bird, which presents a singular appearance to the gaze of the traveller: a large flock will rest motionless on the ground, with their delicate bluish-grey wings extended vertically, and will maintain this singular posture for some time. It deposits its eggs, two in number, on the bare ground, without any attempt at nidification; ovoiconical in form, they measure in length 1 inch 6 lines, with a breadth of 1 inch 1½ lines. In colour very considerable variety is exhibited, dull grey, greenish-white, pale-green, pale-brown, with small brown markings distributed over the surface generally. This Tern is remarkably clamorous at the breeding season; and should a traveller approach their ground, the intruder is instantly assailed by them with swift dartings, accompanied by noisy, harsh, grating screams. The young birds remain about the breeding-ground for some weeks, till they can fly well.

No. A. 131.—STERNA——(?) New Sp.

A very small Tern visits the Rakaia river-bed during the breeding season, not far below the gorge of that great river. There does not appear to exist any description of it, either in Mr. Buller's Essay, Dr. Finsch's Notes, or in Mr. Buller's Paper of August 25, 1868. It lays its eggs, two in number, on the bare ground, they are stone-colour, blotched over with grey markings, and measure through the axis 1 inch 4 lines, with a diameter of 11 lines. It is not at all a common bird in that locality, and was not observed there last year. In the Museum at Christchurch, are two specimens of a small Tern, obtained in the province; in all probability, the eggs noticed above, belong to indi-

viduals of this species. They are labelled *Sternula nereis*, and measure, total length 10 inches 7½ lines, length of wing 9 inches 1½ lines, bill from gape 1 inch 9 lines, tarsus 7½ lines; colour, above, silver or French-grey, forehead white, back of head and nape of neck black, black streak round the eye, bill and feet yellow: the eggs above noticed were discovered in November.

Since the above was written, through the zeal of a friend residing near the Rakaia, we have received two eggs of this interesting bird; they were found in November, hard set. On comparing them with the egg of *S. minuta*, of Europe, in our own collection, we find them of rather a broader oval in shape, of the same length, with a breadth exceeding that of the European species by 1½ lines; but so close is the general resemblance between them, that they might be easily supposed the produce of individuals of the same species. The egg of the Lesser Tern, *S. minuta*, is less eccentric in its colour and marks than those of many other species of the genus.

No. 139.—Graculus brevirostris, Gould.
Black River-shag.

Breeds on the shores of the lakes in the interior, where these birds congregate in considerable numbers, probably depending on the fresh water Unio, for some portion of their food supply. Like the Rook, and the Heron, of Europe, it builds in company, within the space of a few square yards many nests may be counted; the favourite breeding-place appears to be scrub, on some of the steep and lofty banks of the lake shore. The nest is large, chiefly constructed with sticks procured from the dead scrub, amongst which may be found the dead flower-stalks of *Aciphylla squarrosa*, grass forming the lining material. The eggs, four in number, are greenish-white, with the chalky encrustations characteristic of the Pelicanidæ, elliptically shaped, they vary considerably in size, especially in the measurement through the axis, as from 2 inches 6 lines, to 2 inches 2½ lines, with a breadth of 1 inch 6 lines. When freshly procured from the nest they give out that peculiar odour which distinguishes those of the Procellaridæ, in common with the eggs of the Pelicanidæ, truly "a most ancient and fish-like smell."

No. 142.—Dysporus serrator, Banks.
Gannet.

An egg of this bird, in the Colonial Museum, Wellington, gives the following measurements, which correspond very nearly with the size of the English species: length through the axis 3 inches 1½ lines, with a breadth of 1 inch 10 lines. White in colour, with the rough chalky surface which distinguishes the eggs of the Pelicanidæ.

Art. IX.—*Description of two Birds new to the Fauna of New Zealand.* By Captain F. W. Hutton, F.G.S.

[Read before the Auckland Institute, September 20, 1869.]

Nyroca australis, Gould.
White-winged Duck.

I first noticed this bird, about two years ago, on the Whangape Lake, Lower Waikato, and since, on the Waikare Lake, near Rangiriri, and on Rotomahana Lake, where it was abundant in March, 1868. On the lakes of the Lower Waikato it is not uncommon, but is so wary that as yet I have only been able to obtain three specimens, the first of which was kindly

procured for me by A. M. Sheppard, Esq., of Ahiruna. This bird is known to the natives, both of Tarawera and Waikato, by the name of Karakahia. Like all the Pochards, it frequents the lakes only, and is rarely, if ever, seen in the rivers and creeks. I have not yet ascertained where it breeds. The specimen I got from Mr. Sheppard, I sent to W. Buller, Esq., of Whanganui, who identified it with the *Nyroca australis* of Gould's "Birds of Australia."

MALE.—Head and neck, dark reddish-brown; back, brown with the feathers of the upper part tipped with yellowish-brown; breast, white; sides, light-brown; abdomen, brown; wing feathers, white, tipped with brown; under wing-coverts, white; speculum, white; tail, dark-brown; bill, black, with a slate-coloured band near the tip; irides, white; tarsi, grey, front part very light-grey; membranes, black, bordered with light-grey on the side of each toe.

Length, 1 foot 8 inches; bill, from gape to point, 2 inches 2 lines. Wing, from carpal joint to tip 8 inches 3 lines; tarsi, 1 inch 6 lines.

FEMALE.—Head, neck, and breast, reddish-brown, speckled with white on the throat, and black on the breast; upper abdomen, dirty white; wings, same as male; but the white of the primaries is shaded with brown; rest of plumage same as male; bill, greenish-grey, tipped with slate-blue; lower mandible, greyish-blue; irides, light-brown.

Length, 1 foot 7 inches; wing, from carpal joint, $8\frac{1}{2}$ inches; bill, 2 inches; tarsi, $1\frac{3}{8}$ inches. The wind-pipe of the male is much swollen, but not that of the female.

ÆSTRELATA GOULDII, n. s.
Procellaria macroptera, Gould, *nec* A. Smith.

This bird I first noticed in May, 1866, off Tasmania, and thought, at the time, that it would be an undescribed species; but I was never able to examine a specimen until a few months ago, when one was left at the Museum of the Auckland Institute, the donor's name not being known. It is very common on the Tasmanian and New Zealand coasts, and is, undoubtedly, the bird that Mr. Gould refers to as "the dark Petrel with a grey face," which he shot off the coast of Tasmania, and which he suggests might be the *Procellaria macroptera*, of Dr. A. Smith. According to that author, however, the bird he called *P. macroptera*, has no grey face, but a white circle round the eye, and reddish-brown legs and feet, in all of which respects it differs from the present bird, as well, probably, as in its dimensions, although more specimens will have to be measured before this can be determined.

Considering, therefore, this bird to be a new species, I have named it after Mr. John Gould, to whose labours we are so largely indebted for our knowledge of the Petrels of the Southern Seas.

Description.

Upper parts with wings and tail sooty-black, some of the wing coverts with brownish tips; under parts, dark-brown; forehead, cheeks, and chin silvery-grey, shading off gradually into the black before reaching the eye.

Tail rather long, cuneate; wings, when folded, reaching about half-an-inch beyond the tip.

Legs and bill black.

Length, from tip of bill to end of tail . .	16·75	inches
Bill, from gape to point	1·6	"
Wing, from carpal joint to tip	13·5	"
Tail	5·0	"
Tarsus	1·6	"

NOTE.—*Dimensions of* P. MACROPTERA, Smith.

Length from tip of bill to end of tail . .	17·0	inches.
Bill, from gape to point	1·75	„
Wing, from carpal joint to tip . . .	13·75	„
Tail	6·0	„
Tarsus	1·5	„

ART. X.—*On the introduction of the* PHEASANT *into the Province of Auckland.* By Captain F. W. HUTTON, F.G.S.

[*Read before the Auckland Institute, June* 7, 1869.]

EXACT information, as to the date of the introduction of plants and animals into a country, together with the numbers introduced, and the place where they were first turned out, will be of great value, in future years, to all naturalists studying the difficult subjects of the diffusion and replacement of species; and for this reason I have here placed on record all the information that I have been able to collect with reference to the first introduction of the Pheasant into this province; and I hope that any person who is in possession of more complete information, or who may know, with tolerable accuracy, the date of the first appearance of the bird in any part of the province, will kindly inform me.

In 1851, Mr. Thomas Henderson imported some Chinese Pheasants (*Phasianus torquatus*) direct from China, in the barque "Glencoe." Two dozen were shipped, but only seven reached Auckland alive, five of which were cocks. These were turned out near Mr. Henderson's mill at Waitakerei. About the same time, or a little before, some English pheasants (*Phasianus colchicus*) were liberated at Mongonui by Mr. Walter Brodie.

In 1856, Mr. Thomas Henderson imported some more Chinese Pheasants in the schooner "Gazelle," of which six only arrived alive. They were also turned out at Waitakerei.

These thirteen birds, most of them cocks, appear to have been the whole of the Chinese Pheasants imported into the province. For several years they were never seen, but gradually became more and more abundant in the neighbourhood of Auckland, and in the year 1865 they were so common as to be shot in considerable quantities. They seem to have made their first appearance in the Waikato in 1864 or 1865.

They are now extremely abundant from Auckland southwards, all through the Waikato and Thames districts, and have been seen near Lake Taupo. North of Auckland they have not spread so rapidly. They are tolerably abundant at Mahurangi, but are scarce further north. They have this year been seen at Whangarei.

The English Pheasants, although they appear to have multiplied freely at Mongonui, have not spread much, as they have not yet reached the Bay of Islands. Chinese Pheasants have been turned out at Tauranga, Tolago Bay, Napier, Raglan, Kawau, and Bay of Islands, within the last three years.

I may also add that, in 1862, Mr. William Hay turned out at Papakura two brace of Californian Quail (*Ortyx Californica*), these are now in thousands, and have spread for many miles. *O. Californica* has also been turned out at Hokianga, Kawau, Auckland, and Waikato.

NOTE by Mr. T. KIRK.—*P. torquatus*, first seen at Owaha in 1866. Not observed north of the Arapoua (Kaipara) in 1868, although a few birds were seen on the Oruawharo, possibly liberated from a cattle station on that river.

Art. XI.—*On the* Katipo, *a poisonous Spider of New Zealand.* By

F. W. Wright, L.M.B. Toronto, L.M.P. New Zealand.

[*Read before the Medical Section of the Auckland Institute, October 20, 1869.*]

I have presumed to offer for the consideration of the Medical Section of the Auckland Institute the following memorial on the Katipo, a poisonous spider of New Zealand, with a case that occurred in my own practice, believing that the subject deserves a general notice, as it certainly requires colonial investigation at the hands of the medical profession.

In the month of December, 1868, a person of the name of John Huff, living near my residence, came into the surgery complaining that he had been bitten on the shoulder by a spider. He was in the employment of Messrs. Archard and Brown, of Stanley-street, Mechanics' Bay. He was occupied, at the time, in carrying firewood, to supply the furnaces of a brick-kiln; the wood was stacked near the kiln in sedge or coarse grass; this happened between the hours of eleven and twelve o'clock, a.m. At noon he came home to dinner, sat down to table, but upon attempting to eat, found he could not open his mouth, or was scarcely able to articulate, in consequence of stiffness about the jaws. He was alarmed and came into the surgery, when it was difficult to understand what he had to say; all I could learn from him was that he had been bitten by a spider, on the shoulder, in the Bay. Upon examining the spot, I found the surface raised, to an extent as large round as a tea-cup; this elevated surface was white, and was surrounded by a halo of red, not unlike an exaggerated wheal of the nettlerash. He complained of considerable pain in the part, and during the examination became faint, and soon almost pulseless. His pulse was unusually slow, scarcely counting more than twelve or fourteen beats in the minute. His countenance and the general surface of the body assumed a hue of extreme pallor, which gradually turned to a blue tint. His extremities were cold and flaccid; his respiration almost ceased, and indeed I had fears that he was about to expire. Dr. Pinching being in my house at the time, I called for his assistance. He was astonished at the feebleness and prostration of the patient, from such an apparently trifling cause.

From his extreme faintness it was necessary to lay him on the floor, when I applied spirits of ammonia to the wound, which had the effect of lessening the swelling and abating the pain. I also administered ammonia and water, afterwards combined with brandy, in considerable doses; under this treatment his pulse gradually improved, his circulation and respiration became more natural, as was evidenced by his return to a more natural colour. Although a stout strong man, this state of depression remained for upwards of two hours before he was able to return home. In the evening I found him considerably improved, having taken a slight dose of medicine. For several days he could not return to his work, but complained of great lassitude, and nervous depression, which he was sensible of for many days after.

It must be evident from the symptoms of this case, that the man was powerfully affected by a narcotic and irritating poison, which being absorbed into the circulation, affected the heart, brain, and nervous system, to a very considerable extent, almost amounting to fatal syncope,—that the stimulants, by exciting the heart's action, gradually aroused the excretory functions, so as ultimately to remove the poison from the system; for although suffering under its influence for a considerable time, it does not appear to have left any permanent effects behind it, for the man has since been in perfect health.

In corroboration of the nature of this accident, I append the following very graphic description of the bite of the Katipo, furnished by the Rev. Mr. Chapman, whose long residence as a missionary to the Maori race, in the

interior of New Zealand, renders his observations and opinions of peculiar importance.

"In the course of my sojourn in New Zealand, I have had three rather remarkable proofs of the violently poisonous nature of the bite of the Katipo.

"Some twenty years ago a party of natives had taken up a temporary residence at Waihi, near Maketu; their resting place being near the sea-beach. During the period of their morning's meal, a girl was bitten by a Katipo, in the region of the abdomen. She did not seem at first to suffer much pain, but towards noon, inflammation set in, and some native remedies were used. As these had no effect, her friends decided to convey her to my residence, and they reached my house about one p.m. I discovered, on first seeing her, indications of severe pain; and on examining the wound, found a swelling of the size and shape of the obtuse end of a hen's egg. I immediately rubbed the part with strong ammonia. This had no other effect than of lessening the severity of the pain, but failed in decreasing the swelling. I gave the girl also medicine, which was probably salts and tincture of henbane. After this, I saw her nearly every day, for a fortnight, using such means as appeared to me suitable. She seemed at this stage to be gradually recovering, but suddenly became faint and pallid, lost all desire for food, and though offered whatever my house afforded, would only take a little bread and tea, and sometimes a little wine. She lingered in this way for about six weeks and then died.

"The next case was the son of a trader resident at Maketu; three of his boys went up the river on a ramble and lingered at the Tumu, resting themselves by sitting on the tufts of sedge growing on the sand-hills just above the reach of the tide. These tufts are the principal haunts of the Katipo. While so resting, one of them was bitten by this insect, on the fleshy part of the thigh, it having crawled unperceived up his trowsers. The boys were at this time about two miles from home. They returned immediately, but not thinking the bite of any consequence, delayed applying to me until towards evening, at which time the sufferer became ill, and the place bitten inflamed. I attended him, using the same remedies as in the other case; but he suffered long, wasting, and losing all energy, soon having the appearance of one going into a decline. If I recollect correctly, he was three months before he rallied, and probably another three before he fully recovered.

"The next case occurred to that remarkable man Toke, the chief of Maketu. We were travelling together up the coast from Whakatane, and halting to dine, he seated himself upon a large tuft of sedge. He had not been resting many minutes before he sprang upon his feet, saying, 'I am badly bitten by a Katipo.' He was bitten on the upper part of the thigh. I directed him to lie down; I then dissolved some carbonate of soda in a very small quantity of water, and adding to this some brandy from my flask, I quickly made a crucial incision over the part bitten, and squeezed out forcibly, the blood, and then rubbed in this antacid solution, keeping up this action alternately for some ten minutes, when he said he no longer felt the pain. He remarked on rising, 'Had you not been with me, I should have had a long illness.' Only two or three minutes could have elapsed after the bite, before a spot about the size of the top of the little finger appeared, and of a peculiar white colour, in strong contrast with the dusky shade of Toke's skin. He was very careful to secure all the blood I had forced out of the wound I had made, by absorbing it in a piece of rag torn from his shirt; this relic, now so doubly sacred, he carried into the middle of a swamp close by, and I saw him stamping it down into the ground very violently, to preserve it from possible desecration.

"The natives generally avoid sleeping on the sea-beach, but have no fear of the Katipo half a stone's throw inland of the sea-beach line. I never knew

them (of themselves) use any other remedy than rubbing and applying hot, half-scalded leaves to the part, and as soon as convenient taking the bitten one to the priest, to receive the benefit of his incantations, as they then believed in the efficacy of prayers, made to their gods of the hills and valleys."

Here again are the evidences of a narcotic and irritating poison, whose absorption into the system produced more permanent effects upon the body; the elimination of the poison had not been so perfect and rapid as in Huff's case. The strength and tone of the constitution in these individuals was, in all probability, not so powerful, hence the elimination of the poison was not so ready, producing a more permanent influence, in all probability causing a degraded condition of the constitution, a blood-poisoning, that caused subsequent disease. Again, in all these cases the effect of the poison may, in some degree, have been modified by the condition of the insects' poison-bags, the locality and character of the bite, under any circumstances, however, it is plain that the deleterious effects of the bite of the Katipo, and its poisonous character, has long been recognised and feared by the natives; and in Huff's case was plainly demonstrated. In Toke's case we can but admire the skill and decision of the missionary, who, all alone in a wild and savage land, could have treated the case so actively and with such good effect,—he, in all probability, preventing the absorption of the poison into the system, by the means he employed.

From all the information that I can collect, the Katipo is a small spider of about half an inch to three-quarters of an inch in diameter, measuring across the body and legs, according to the authority of Major Heaphy, who having been Surveyor-General of the Colony, has had abundant opportunity to know the insect, and is familiar with its resorts.

The Katipo are said to be of two kinds,—one having a dark-glossy body, with a marked red spot on the back; the other, of about the same size, having a similar round black and shining body, but without the spot.

Mr. Taylor, in his book, "A Leaf of the Natural History of New Zealand," writes thus: "The Katipo—venomous Spider—one kind red, and one black with a red spot upon its back. Their bite appears to be very poisonous, occasioning a violent swelling of the part." Major Heaphy is inclined to believe that Mr. Taylor is mistaken in describing a red Katipo; but agrees with him that the one with the black body and red-vermilion spot upon its back, is the most poisonous.

A difference in the habitat of the Katipo would seem to point to a variety, the one inhabiting the sandy beaches of the sea-shore, taking refuge among the drift wood and roots of sedge or rushes found there, while the other one, with the black body without the red spot, may be discovered in the garden, or among the rafters of any old building.

Major Heaphy says, "I saw one, with the red-vermilion spot upon its back, at Massacre Bay, near Nelson, in the Middle Island; a native there obtaining it for me, after a few minutes' search, for a small reward. It was found among the roots of the Wiwi, or rush, around some dry drift wood, on the sandy beach. The natives were very careful not to allow it to touch them, they said it would kill them; but on close enquiry they admitted they never knew of a case of the bite ending fatally, although the bite from them was not uncommon. Great suffering, however, they said ensued, the part swelling considerably."

On the original plan of the North Shore, near Auckland, the sea beach nearest the north side of the lake, was indicated, in a marginal note, as very celebrated for the number of Katipo existing there.

The other variety, with the black body without the red spot, is of about the same size as the other, of a dark glossy brown or black colour. This, as

well as the preceding, is a very beautifully shaped insect, the abdomen is, as generally seen from above, perfectly spherical, like a "number one".shot, very glossy. The legs are compact, not straggling. It is found amongst dead wood in a garden, and, with a slight web, amongst the rafters of an out-building or loft. The natives have no distinguishing name for either variety, they are both called Katipo, to distinguish them from the Punga-were-were, or common Spider.

I have never heard of a case of bite from one of this kind, but the natives say that they are equally venomous with the spotted variety. I am convinced that the one with the red spot, indicates a different variety, and is not the result of age or sex, as among hundreds of the black kind I never saw a spotted one.

There is no doubt but that several of the Arachnidæ are of a poisonous character, that their mandibles are furnished with a curved claw, perforated at the extremity something like the poison-fang of a venomous snake, and used for a similar purpose. A gland furnishes a secretion which is forced through these organs, and is injected into any object that may be wounded by the sharp claw. The fluid which is secreted for the service of the fangs is nearly colourless, and is found to possess most of the properties that exist in the venom of the rattle-snake, or viper.

It is certain that the bite of a moderate-sized Spider will kill a house-fly in a few seconds. Without believing all the stories that have been told of the Tarantula, it is certain that its bite is poisonous,—that it is of a character similar to that of the Katipo. Dr. Graperon states, that he saw two cases in which the bite of the Tarantula proved fatal in the Crimea,—one in forty-eight hours, the other in six days. The wound, which was inflicted on the patient's neck, was very painful, and had left a brownish-violet mark; the head, neck, and shoulders were swollen; from the clavicle to the false ribs was of a bluish colour, and respiration became difficult forty-four hours after the injury. Scarifications, the actual cautery, oil externally and internally, and ammonia, were all employed in vain. A comparison of the symptoms in this case with those exhibited by Huff, will surely bear me out in the conclusion, that the poisons are similar, at least in their effect.

ART. XII. — *On four* FISHES *commonly found in the River Avon; with a consideration of the question: "What is Whitebait?"* By LL. POWELL, M.R.C.S.St.A.

[*Read before the Philosophical Institute of Canterbury, December* 2, 1869.]

I VENTURE to hope that an attempt to settle the vexed question, "What is Whitebait?" will not be unprofitable. The fish, in question, is one of the most important of our fresh-water fishes, and forms a very agreeable variation in our somewhat-restricted colonial diet. A similar question has been raised, from time to time, regarding the English Whitebait, which has been looked upon as the young of the Sprat, the Shad, and the Herring. Naturalists are now, however, tolerably well agreed that it is an adult fish of a distinct species; and it appears amongst the Clupeidæ under the name of *Clupea alba.* The New Zealand Whitebait has no affinity with the English fish, whose name it bears, not belonging to the same family, even; and the question at issue is this, "Is the Whitebait an adult fish, or the young of some other species? if the latter, what is its adult form?" Attempts have been made to solve the doubt, by keeping Whitebait in confinement, so that they might develope under observation, but these experiments have always been performed without

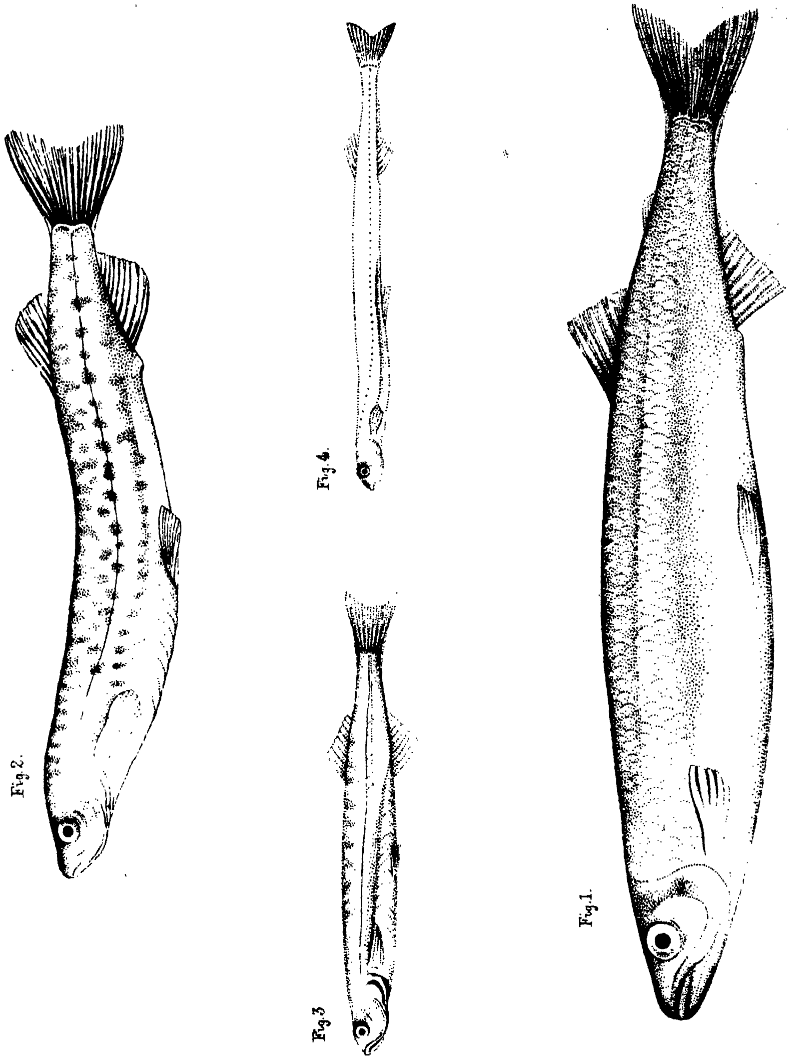


Fig. 1. Fig. 2. Fig. 3. Fig. 4.

To illustrate Paper by Ll. Powell on WHITEBAIT.

1. SILVER FISH. (*Argentina retrospinna half grown Ed.*)
2. SMELT. (*Galaxias fasciatus Gray.*)
3. WHITEBAIT. *2nd Stage.*
4. WHITEBAIT.

J. Buchanan lith.

Printed at the Gen. Gov. Lith. Press by J. Earle.

sufficient care being taken to exclude sources of error. Mr. Johnson, the curator of the Acclimatization Society, has introduced Whitebait into the fish-ponds in the gardens, and is convinced that they grow and develope into what he designates Smelts. He, yesterday, showed me, in the ponds, a shoal of these fish; they were certainly much larger than average Whitebait, and had somewhat lost their vermiform shape, we could not, however, succeed in catching any of them,—I am glad to say, however, that he captured some this morning; I shall have something to say about them in the sequel. Mr. Bealey also tells me that he put a number of Whitebait into a reservoir supplied only with artesian water, and that they developed into Smelts, and such seems to be the general opinion. Unfortunately, two very distinct fish are confounded together under the name of Smelts, and the observers are not sufficiently positive as to which particular fish the Whitebait became. If, on comparison, the Whitebait should not correspond, in general characters, with any larger fish common in the Avon, we shall be quite justified in rejecting these observations as careless, and inaccurate; if, however, the Whitebait agree closely in generic and specific characters with some larger and common fish, the experiments rise in importance.

This has led me to institute a comparison between the Whitebait and such other fishes as are found commonly in the Avon, with a view to deciding this question, and I now proceed to lay the result of these observations before the Society. I do so, however, with considerable diffidence, partly because I have not hitherto devoted my attention to fishes, and partly because I am almost entirely destitute of works of reference in this particular line, and our libraries are in the same condition; I shall, therefore, endeavour to confine myself to plain and prominent characters, and crave indulgence to any possible errors.

The Whitebait averages two, to two and a half, inches in length; it is anguilliforous in form; and, in its transparency, and the size and prominence of its eyes, has the appearance of an immature fish. It is scaleless, has a transparent greenish tinge, possesses six fins, excluding the caudal fin, which is rather large and forked.

A row of distinct black spots runs along the lateral line. The swim-bladder is large and distinct, its situation being bordered by a band of black spots. The teeth are microscopic. The fin rays are all soft, and the abdominal position of the ventral fins refers them to the *Malacopterygii abdominales*; whilst the single dorsal fin, the absence of scales, and of a spine in the dorsal fin, indicate that it is a Galaxia.

Its specific characters are as follow:—

One dorsal fin; first ribs of dorsal and anal fin in a line, one-third of the length of the body from the origin of the caudal fin; ventral fin abdominal, one-third the length of the body behind the pectorals; teeth, imperceptible; fin rays: (P.) 11 or 12, (V.) 7, (D.) 10, (A.) 16, (C.) 16.

There are only three fish in the River Avon, sufficiently common to justify the supposition that either of them may be the adult form of the Whitebait; these are the Bull-head, the Silver-fish, and the Smelt. The name of Smelt is applied indiscriminately to the two latter fish, we will, however, retain the trivial name of Silver-fish as a distinction. We may first dismiss the Bull-head, there is no possibility of confounding the Whitebait with this fish; it is thoroughly well-known, both in its adult and young form.

It is an Acanthopterygious fish, with two dorsal fins, the first having simple, though flexible rays, it belongs to the sub-class Acanthopterygii, family Gobioïdæ, genus Eleotrinæ, and is probably the *Eleotris basalis*, described by Dieffenbach; though Dieffenbach's description is too meagre to decide positively. Its characters are as follows:—Head, large, one third the length of the body, which is tapering in form; colour, dark-brown, mottled of a

darker tint, with five blackish bands, transversely covered with a slimy secretion; scales, large and pectinated; gill openings, very wide; gape, small; teeth, microscopic, and densely set; branchiostegal rays, five. No swim-bladder; dorsal fins, two in number, large, the first having simple flexible rays; ventrals, distinct, sub-pectoral; anal fin opposite to second dorsal; the fins all banded with black. Fin rays (1st D.) 7, (2nd D.) 10, (P.) 13, (V.) 5, imperfectly developed, (A.) 10, (C.) 15 or 16.

The Silver-fish again belongs to the *Malacopterygii abdominales*, or fishes having soft fin rays, with the ventral fins placed beneath the abdomen. In its bright silvery colour, it possesses a superficial likeness to the Whitebait, it has, however, no affinity with it.

Everyone will recognize the likeness to the true English Smelt, *Osmerus Eperlanus*, both in appearance, and in its remarkable smell, when freshly removed from the water, likened, by some to cucumbers, by others to violets; but although it belongs to the same family, the Salmonidæ, it is not a Smelt, as the position of the first dorsal fin indicates, which in the Smelt is situated over the ventrals. The second dorsal adipose, the well-marked cycloid scales, refer the Silver-fish to the Salmonidæ, but to what genus of this numerous and difficult family it belongs, I am quite unable to decide; it has the following characters:

Two dorsal fins, the second adipose and destitute of rays, colour, grey with a silvery band down the sides; belly, white; teeth, small and numerous; branchiostegal rays seven; anal fin slightly in advance of second dorsal.

Fin rays, (P.) 10, (V.) 6, (1st D.) 11, (A.) 17–18, (C.) 18.

We now come to the last fish on our list, called, by boys, the Smelt; but why a Smelt, I know not. And now, even on a superficial examination, we perceive an affinity to the Whitebait, in the absence of scales like the Whitebait; the Smelt is a Galaxia, soft fin rays abdominal, ventrals, a single dorsal, no scales, and the dorsal destitute of a spine. It has a yellowish-brown colour, dotted with black spots, which are especially numerous in the neighbourhood of the lateral line; 1st rib of the anal fin opposite to the third dorsal, and very near the caudal fin; ventrals, half way between gill covers and origin of caudal fin.

Fin rays, (P.) 9 or 10, (V.) 7, (D.) 9, (A.) 15 or 16, (C.) 16.

We will now institute a comparison between the Whitebait and the Smelt.

The fishes from which these notes were taken, were obtained on different occasions, and the characters noted down separately. I have arranged the specific characters in parallel columns, and will give them, seriatim:

WHITEBAIT.	SMELT.
Scaleless.	Scaleless.
One dorsal fin.	One dorsal fin.
Ventrals, one-third length of body behind pectorals.	Ventrals, midway between gill covers and origin of caudal fin.
First ribs of dorsal and anal fins on a line, one-third length of body from origin of caudal fin.	First anal rib about opposite to third dorsal and near caudal fin.
Fin rays.	Fin rays.
P. 11	P. 9 or 10
V. 7	V. 7
D. 10	D. 9
A. 16	A. 15 or 16
C. 16	C. 16

There is a slight discrepancy in the proportions, but in no respect more than would be expected between a young and an adult fish: the number of

fin rays corresponds almost exactly, and the difficulty of counting the rays in the Whitebait is considerable, as they are more and more rudimentary at the commencement and terminations of the fin. I wish to direct your attention to this drawing of a Whitebait, which has been in the Acclimatization Society's ponds a short time. I think anyone would say it was a young Smelt, it has lost its Eel-like appearance, and is assuming the colour and markings of the adult Smelt.

In concluding this contribution to the natural history of the fresh-water fishes of the River Avon, I may say that I am quite satisfied that the Whitebait is the young of the Galaxia, commonly known as the Smelt, but if any of the members doubt it, let me urge on them the propriety of setting the question at rest in one of two ways; either by developing Smelts from their ova, and observing whether they pass through the Whitebait stage; or, secondly, by preserving the Whitebait themselves and watching their development, care being taken to exclude all sources of error, such as the access of the ova of other fish. Such an experiment is easily tried, and would be decisive.

ART. XIII.—*On the* NEW ZEALAND FROG (Leiopelma Hochstetteri), *with an account of a remarkable feature in the history of some species of Australian Frogs.* By A. WANDER AITKEN.

[*Read before the Auckland Institute, November* 15, 1869.]

WHILE engaged in making an examination of the Thames Gold-field, I was rather suprised to find that frogs existed in situations that no imported animals can possibly have reached. I have always been led to believe that no animals of the frog kind existed in New Zealand, and a long experience in the inhabited and uninhabited portions of the islands, had almost confirmed that belief. That the frogs, referred to by me, are indigenous to New Zealand, I have no doubt, as they are quite different from any species I have hitherto seen or read of. I have much pleasure in forwarding one herewith, which I took from one of the range-creeks in the neighbourhood of Puriri. The portion of the creek from which it was taken is about 500 feet above the level of the Thames river, and below that point the creek is a succession of water-falls, and very steep. In forwarding this specimen, I should like to bring under the notice of the Institute a feature in the natural history of the frog, at present (I believe) unknown to the scientific world, but which must be of the deepest interest, not only to the student of natural history, but also to the student of geology.

There are districts, often exceeding 5000 square miles in extent, in the interior of the Australian continent, in which there is no surface-water for many months, and, in some instances, for years; yet as soon as rain falls in sufficient quantities to fill the water-holes, they are swarming with young frogs. Before the rain fell, one might dig for ten or twelve feet without finding the slightest moisture, much less water; the whole of the ground is baked hard and perfectly dry, and no sign of animal life apparently exists in it, or on it.

Even vegetable life has almost ceased to exist, and the only remnant left is a withered and half-dead Salt-bush, here and there. Yet rain on such country had the effect of changing, as if by magic, the whole aspect of affairs, —comparatively speaking, a desert, was, in a day, transformed into an Eden. Plants sprung up everywhere, ducks and water-hens appeared in vast numbers, and swarms of tadpoles peopled the water-holes. I could easily account for the vegetable life, and for the wild-fowl; but the tadpoles puzzled me, till a native boy, not more than ten years old, opened my eyes, and satisfactorily solved a

problem in geology, which had never been, to my mind, satisfactorily solved by the greatest geologists who have written on the subject. Mr. A. W. Howitt, and I, with a black boy of the age above-mentioned, had made a two days' journey on horseback, from the last known water, without finding any more, and had we gone on further our horses would probably have been unable to return. We were much in want of water, and had camped for the night in the midst of a great many dried-up water-holes, with a few Salt-bushes growing on their margins, intending to turn next morning.

I noticed the boy examining the dry surface of the water-holes, and went to see what he was doing. He pointed out an indistinct and crooked mark, on what had once been the mud, and following it to where it apparently ceased, in the shade of a small Salt-bush, he began to dig with a sharp stick, and in a short time turned out a ball of clay about eight inches in diameter, and quite dry outside, which, when broken, disclosed a frog shut up in a beautifully puddled cell, with more than half-a-pint of fine, clear, cold water. We afterwards dug out many others, drinking the water, and eating the frogs. A sudden or gradual deposition of matter over such ground, would have shut up those frogs for ever, and if they live through months and even years, in such a situation, within range of the effects of a scorching sun, we can understand how they have lived for ages in the cool and moist recesses of the rocks in which they are sometimes found. The theory of living frogs getting *accidentally* buried in accumulating mud or sand, if examined, will not stand good, for the compression to which such rocks are sometimes afterwards subjected, would certainly kill them; while the cells, in which I have seen them, would stand compression to half their original bulk, without materially affecting the animal.

II.—BOTANY.

ART. XIV.—*On some new species of* NEW ZEALAND PLANTS. By JOHN BUCHANAN, of the Geological Survey Department.

[*Read before the Wellington Philosophical Society, November* 13, 1869.]

Ozothamnus lanceolatus, Buchanan. n. sp.

A small shrub, 2–4 feet high; branches slender, tomentose at the tips, grooved. Leaves, 1½ inches long, narrow, alternate, lanceolate, slightly waved on the margins, entire or obscurely crenate, white and cottony beneath, finely reticulated on the upper surface, spathulate or contracted into a winged petiole ¼ inch long. Heads in small, lateral, peduncled corymbs, involucral scales, scarious, woolly at the base, pappus hairs thickened at the tip. Achene glabrous.

Allied to *Ozothamnus glomeratus*, but easily distinguished by the lanceolate leaves and glabrous achene. Habitat, mountains of Hokianga 2000–3000 feet alt. Collected by Mr. J. Buchanan.

Geum uniflorum, Buchanan. n. sp.

A small herb, 6–8 inches high; rhizome, prostrate, stout, woody. Leaves 1½–2 inches long, pinnate; leaflets, one pair, very small, crenate; terminal leaflet, reniform, 1 inch broad, obtusely crenate, nearly glabrous on both surfaces, but with a marginal row of pencils of stiff orange hairs on the edges of the crenatures. Flower, large, 1–1¼ inches dia., white, terminal on a

slender villous stem. Calyx lobes, oblong, obtuse, villous. Styles, subulate, tips hooked, villous at bottom, with long hairs.

Allied to *Geum parviflorum*, and distinguished by the large single flower, orange pencils of hairs on the crenatures, and minute single pair of leaflets. Habitat, mountains of Nelson, 3000–4000 feet alt. Collected by Mr. H. H. Travers.

Senecio laxifolia, Buchanan. n. sp.

A woody shrub. Branches, petioles, leaves below, and inflorescence, covered with buffish-white tomentum. Leaves with slender petioles, $\frac{1}{2}$–$1\frac{1}{2}$ inches long, blade, 1–$2\frac{1}{2}$ inches long, narrow, oblong, tapering, acute at both ends, flat, crenate or obscurely crenate, finely reticulated above, and with flocculent tomentum on the midrib, slightly coriaceous. Corymbs, very open, on long slender peduncles, 3–7 inches long, with a few narrow, linear leaves, $\frac{1}{4}$–$\frac{3}{4}$ inch long. Heads, broad cylindric, $\frac{1}{2}$–$\frac{3}{4}$ inch dia., rays, $\frac{1}{3}$ inch long, revolute, pappus hair, white, scabrid; achene, grooved, glabrous.

Allied to *Senecio Monroi*, but easily distinguished from it by its habit, larger flat acute leaves, which are never wrinkled on the margins, long peduncled corymbs, larger flowers, and absence of glandular pubescence on the involucre and pedicels. Habitat, mountains of Nelson, 3000–5000 feet alt. Collected by Mr. H. H. Travers.

ART. XV.—*On the* BOTANY *of the Thames Gold-fields.* By T. KIRK.

[*Read before the Wellington Philosophical Society, November* 13, 1869.]

THE country between the Waikawa and Kawaeranga creeks consists, for the most part, of steep hills and narrow gullies, and presents but few variations in those features which influence the character of its vegetation. From the Kawaeranga northward to Kurunui, a gradually-narrowing strip of alluvial land, much of which is now occupied by Shortland and Grahamstown, still exhibits dense thickets of *Olearia Solandri*, Hook. f., *Plagianthus divaricatus*, Forst., *Muhlenbeckia adpressa*, Lab., *M. compressa*, Mein., *Coprosma* sps., *Dodonæa viscosa*, Forst., with a close undergrowth of sedges and other uliginal plants, the most conspicuous of which is *Cladium junceum*, Br., often found covering large spaces, to the exclusion of other plants. The mud-flats and margins of the creeks are occupied by the Mangrove, *Avicennia officinalis*, L., which is here abundant and attains a large size, *Chenopodium ambiguum*, Br., *Leptocarpus simplex*, A. Rich, *Selliera radicans*, Cav., *Samolus repens*, Pers., *Scirpus maritimus*, L., and rarely *S. triqueter*. L.

At various points along the coast, small patches of sand admit of a sparse growth of arenarian plants, the most common being *Convolvulus Soldanella*, L., and *Carex pumila*, Thumb.; the Pingao (*Desmochœnus spiralis*, Hook.), a plant which, in the north, at least, is common on shifting sand, usually within the influence of the sea-spray, is here found only in small quantity and apparently confined to a single locality. Occasionally, as in the neighbourhood of the Tararu, the Waionau, and other creeks, alluvial flats of sufficient extent to have been used as cultivations by the Maoris, are now more or less clothed with a dense growth of Tauhinu (*Pomaderris phylicifolia*, Lodd.), Manuka (*Leptospermum scoparium*, Forst.), Koromiko (*Veronica salicifolia*, Forst.), and fern (*Pteris esculenta*, Forst.), with an abundance of naturalized plants, waifs of cultivation, grasses, and other stragglers, which are again mixed with a few coarse-growing native plants of herbaceous habit.

In the neighbourhood of Shortland and Grahamstown, the hills are usually much broken and precipitous, and attain their greatest height, 2300 feet, near the head of the Kawaeranga creek: the beds of the different creeks are frequently mere ravines, the sides of which are thickly clothed with mosses, various species of Gottschea and Plagiochila: *P. Stephensoniana*, Mitten, attaining unusual luxuriance; in less moist places a rare moss, *Mielichoferia tenuiseta*, Mitten, covers the surface and forms a suitable medium for the growth of various species of Corysanthes, especially *C. rivularis*, Hook. f., and rocks and trees alike are clothed with a rich covering of various ferns, more especially *Hymenophyllum dilatatum*, Swartz., *H. scabrum*, A. Rich., *H. æruginosum*, Carm., and *Trichomanes reniforme*, Menz. The slopes of the hills are usually covered with a dense forest of timber trees, and undergrowth, the forms being chiefly the Hinau (*Elæocarpus dentatus*, Hook.), Toro (*Persoonia Toro*, A. Cunn.), Tawa (*Nesodaphne Tawa*, Hook. f.), Beech, or Black Birch (*Fagus fusca*, Hook. f.), Kauri (*Dammara australis*, Lamb.), Miro (*Podocarpus ferruginea*, Don.), Totara (*Podocarpus Totara*, A. Cunn.), Rimu (*Dacrydium cupressinum*, Soland.), etc., with *Alseuosmia macrophylla*, A. Cunn., *Schefflera digitata*, Forst., *Coprosma grandifolia*, Hook. f., *Senecio glastifolius*, Hook. f., and immense tussocks of an undescribed Astelia, and cutting grasses (*Gahnia lacera*, Stend., *G. arenaria*, Hook. f.): the Supplejack (*Rhipogonum scandens*, Forst.), and Mange-mange (*Lygodium articulatum*, Swartz.), are so mixed with the undergrowth as to render all progress tedious and laborious in the extreme.

A remarkable feature, in some parts of the district, is the social character of the arborescent ferns, more especially of the Mamaku (*Cyathea medullaris*, Swartz.), and the Weki (*Dicksonia squarrosa*, Swartz.), which occasionally form groves of small extent; the Ponga Flat, a comparatively level piece of land at an altitude of about 1650 feet, owes its name to the large grove of Black Tree-ferns with which it was formerly covered. A few specimens have been spared and are carefully protected by the miners.

North of the Tararu creek, the hills next the sea are of lower elevation, and more rounded in outline, their slopes being chiefly covered with a varying growth of *Pteris esculenta*, Forst., *Leptospermum scoparium*, Forst., *Pomaderris phylicifolia*, Lodd., *Dracophyllum squarrosum*, Hook., f., *Coriaria ruscifolia*, L., *Epacris pauciflora*, A. Rich., and a few straggling grasses, varied by occasional patches of forest. The tributary streams are choked with a close growth of Typha, Schœnus, Cladium, Carex, and other marsh-loving plants. But a few miles inland these ericetal and uliginal plants disappear, the streams become narrowed and impetuous, the hills steeper and higher, clothed everywhere with a dense bush, often nearly impassable from the abundance of Mange-mange, which binds trees and undergrowth together in an almost impenetrable mass. The highest peaks of Mount Wynyard, 2690 feet, are approached by connecting wall-like ridges, often not sufficiently wide to admit of two persons walking abreast, and covered with tussocks of Astelia, Gahnia, and various shrubs.*

About the height of 1800 feet a change is usually observable in the character of the vegetation; in broken rocky places there is a profusion of mosses and lichens, chiefly belonging to genera Racomitrium, Dicranum, and Cladonia, with a varying shrubby growth of Weinmannia, Leptospermum, Pittosporum, Coprosma, Phebalium, Quintinia, and many ferns. On more even ground *Weinmannia silvicola*, Banks and Sol., and *Metrosideros lucida*, attain

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* One of these ridges is completely blocked by an immense Rata, *Metrosideros robusta*, A. Cunn., the trunk of which overhangs both edges of the mural precipice, and can only be passed by the aid of the friendly climbers, and the tussocks of Astelia which partially cover its base.

a large size, associated with *Ixerba brexioides*, A. Cunn., and *Phyllocladus glauca*, both of which attain their maximum of growth at about 2000 feet, although found in abundance at a greater elevation; in fact they occur on the highest peaks, together with *Dracophyllum Traversii*, Hook. f., *Archeria racemosa*, Hook. f., *Griselinia littoralis*, Raoul., *Dacrydium Colensoi*, Hook. f., *Panax Colensoi*, Hook. f., and many others of greater vertical range. Although from the steep character and ridge-like form of these ranges, water cannot, in some places, be obtained at an altitude of more than 1200 feet, yet the abundance and luxuriance of the mosses and hepaticæ, which clothe the summits, attest an atmosphere continually charged with moisture.

The trees and shrubs that have been utilized either as timber for house or ship-building, or for fencing, are the Kauri, Rimu, Totara, Miro, Beech or Black-birch, Manuka, Rawiri, Puriri, Pohutukawa, Rata (*Metrosideros robusta*, A. Cunn.), Tawa, and more rarely, the Tanekaha, Tawari (*Ixerba brexioides*, A. Cunn.), and Toro. The utilization of the Beech, affords a marked extension of the economical range of the genus to which it belongs, as, although largely used in the South, its timber is usually neglected in this part of the colony, although its bark is occasionally sent to the tan yards. It is now being largely used in the construction of the Moanataiari tramway, which will afford a good opportunity of testing its durability.

While on this subject, I may remark, the waste of timber on some parts of the field has been excessive, and will be severely felt by the miners at no distant period. The Kauri has been preserved to a great extent, as the sum of twenty-five shillings is required for each tree cut down. The Pohutukawa, which from its value to the ship-builder, has contributed largely to the progress of this part of the colony, is without the benefit of protection, and has been in some cases recklessly cut down for firewood, a proceeding which is said to have been commented upon by the Maoris. Although confessedly difficult, it would seem not impracticable to prevent this wanton destruction of valuable timber, by legislative enactment; it is certainly desirable, in the interest of the miners themselves, no less than in that of the colony at large.

Naturalized plants are to be found in great abundance in all situations, except on the highest ranges. The most common forms are identical with those found to the north of the Waitemata, and occur in nearly the same proportion, as will be seen from the following list, which is arranged in the order of their relative abundance over the entire district:—

Erigeron canadensis, L.
Hypocharis radicata, L.
Anagallis arvensis, L.
Medicago denticulata, Willd.
Lolium perenne, L.
Euphorbia Peplus, L.
Rumex obtusifolius, L.
Plantago major, L.
Helminthia echioides, Gaert.
Briza minor, L.

The most notable exception in the above list is the Milk-weed (*Euphorbia Peplus*, L.), which in many northern districts, would rank second or third on the list, instead of sixth; the position of one or two species in the list, might possibly be altered by an examination of the district in December, instead of April. The former extent of native cultivations is attested by the common occurrence of the Tara (*Colocasia esculenta*, Scholl.), and several of the cultivated fruits of Europe, the peach, cherry, fig, vine, raspberry, strawberry, all of which are propagating themselves without the assistance of man, and are

probably deteriorating in quality even more rapidly than they are increasing in number. A close analysis of the indigenous species found in the district, shows that fully four-fifths of the entire number are common to both the North and South Islands; the remaining fifth being peculiar to the North.

NEW OR CRITICAL SPECIES; VARIATIONS, ETC.

Drimys colorata, Raoul. A small shrub with membranous leaves, green on both surfaces, is doubtfully referred to this form, in the absence of flowers. The ordinary forms of *D. axillaris* vary widely in the texture of the leaf, the hairiness of the midrib, and the length of the peduncle.

Viola filicaulis, Hook. f. Identified in the absence of flowers. Extremely local, and probably attains here its northern limit.

Pittosporum Huttonianum, n. sp. A somewhat-irregularly branched shrub or small tree, 12–25 feet high, with black or dark-brown bark, young branches slender, and with the leaves and petioles clothed with white floccose tomentum; leaves alternate, oblong or ovate, obtuse or acute, rarely acuminate, 3–5 inches long, slightly coriaceous when old; petioles slender, ½–¾ inches long; flowers axillary, solitary, or rarely in twos on a common pedicel, peduncles downy, ½–¾ inch long; sepals lanceolate, acute, somewhat bullate at the base, downy; petals ligulate, sharply recurved at about half their length; the corolla never presenting the rotate appearance seen in *P. tenuifolium*; ovary pubescent, peduncles twice or thrice the length of the sepals; bracts at the base of the peduncle, deciduous, capsules erect, 2–3-valved, downy, larger than in *P. tenuifolium*. In the flowering season the tomentum at the back of the leaves presents a cobwebby appearance, and falls off in large quantities.

I have named this handsome shrub after my valued friend Captain Hutton, F.G.S., who was my associate at its original discovery, on the Great Barrier Island.

Pittosporum Kirkii, Hook. f., n. sp. A handsome laxly-branched shrub when growing freely, 3–15 feet high, branchlets stout, rigid, ascending; bark reddish-purple, leaves alternate, crowded or whorled, linear-obovate, acute or obtuse, 2–5 inches long, gradually narrowed into rather broad purple petioles, excessively coriaceous, glabrous, pale-green above, lighter below, midrib stout, prominent and curiously flattened beneath; flowers terminal in 3–7 flowered umbels, peduncles rather stout, decurved; sepals broadly lanceolate with membranous margins; petals ligulate, bright yellow, recurved; capsules erect, clustered, glabrous, elliptic, 1–1½ inches long, obtuse, 2-valved, remarkably compressed, but the valves contract in a curious manner when the capsule bursts.

Usually in rocky woods, often epiphytic, observed only between 1600 feet and 2700 feet. Originally discovered on the Great Barrier. One of the most strongly marked species of the genus.

Elæocarpus Hookerianus, Raoul. A few small specimens of this plant were seen on high peaks, with *all* the leaves orbicular or narrow-linear, and curiously toothed and lobed; the branches shortened and curiously aggregated, forming an impervious mass of close growth. This was not simply the result of exposure, as notwithstanding the altitude at which they grew, they were sheltered by larger trees. In the Waikato, trees with leaves similar to the above, are to be seen, amongst those of the ordinary mature form, on every large tree; in other localities in this province, the smaller leaves are not to be met with. There appears to be some reason for supposing that two forms are included under the name.

Pomaderris Edgerleyi, Hook. f. Apparently confined to the sea-cliffs in this district; in one locality occurring in immense abundance, and attaining a stature of 6–9 feet; the most southern locality known for this remarkably

local plant. There are good grounds for supposing the existence of an undescribed species, attaining the height of 20 feet.

Metrosideros robusta, A. Cunn. A dwarf form, 3–5 feet high, usually laden with old capsules, occurs at an altitude of 1800 feet, and upwards, and in the absence of flowers and perfect fruit is referred to this species.

Metrosideros tomentosa, A. Cunn. There appear to be three principal forms of this tree, chiefly dependent upon habitat. (1). On rocky cliffs, and in open places by the sea, it attains a large size, and is marked by its spreading, gnarled, and distorted branches. (2). In woods near the sea it attains its greatest height, and is of comparatively close and erect growth; known to bushmen as "inland Pohutukawa." The flowers of this form are smaller and less brilliant than the others. (3). A coppice form, rarely more than 12 feet high sparingly branched, and of erect, compact growth, flowering freely, the petals being usually more acute than in either of the other forms. In large patches on sandy soil not far removed from high-water mark; makes capital firewood. A specimen of the first-named form occurs on the beach at Tapu, the trunk of which has a girth of upwards of 17 feet, and the two principal arms of 11 feet and 8 feet respectively. It is of remarkably symmetrical proportions. Chiefly through the public spirit of William Buckland, Esq., it has escaped the destruction which has befallen other noble specimens at Tapu, and has been enclosed by a protecting fence.

Panax, n. sp. A shrub or small tree 6–20 feet high, diœcious, bark and leaves, especially on the under surface, having a peculiar bronzed appearance, when fresh. Leaves on rather slender petioles 1–2 inches long, 3-foliolate, leaflets 2–3 inches long, obovate lanceolate, cuneate at the base, coarsely and sharply toothed, never sinuate-pinnatifid, glossy; rarely a few unifoliolate leaves are found intermixed with the ordinary form. Panicles invariably terminal, male of few rays 2–3 inches long, flowers in slender pedicels $\frac{1}{4}$–$\frac{3}{8}$ inch long; female much shorter, rays and pedicels stouter, fruit nearly as large as in *P. Lessonii*, styles 5-cuneate at the base, tips recurved, flowers greenish-yellow.

Somewhat resembling *P. Simplex*, but the leaves are trifoliolate in all stages, the panicles diœcious and terminal, and styles 5. Found also on the Great and Little Barrier Islands, from the sea-level to the highest peaks; and I have long known a solitary clump of small barren trees in the forest at Omaha, which I wrongly referred to *P. Sinclairii*, when first observed.

Panax arboreum, Forst. This plant assumes two marked forms, which present wide external differences, although difficult to distinguish on paper. (1). A shrub or small tree, in the former state with stout, rather long, branches, and large leaves, the branches ultimately becoming shorter, and the leaves shorter, as the tree grows old, when it presents an unattractive appearance. (2). A shrub with many short and stout branches, leaves more glossy and of a deeper green, much larger and bolder than in the last; petioles stouter with wider bases, umbels much larger, and rays more deeply channelled. The first is the common form at the Thames, and is often clothed with *Tupeia antarctica;* the last, which would form a handsome plant for the shrubbery, I have only seen at the Thames, and in the Waikato. Both forms may be seen growing together.

Panax Colensoi, D. C., appears to find here its northern limit, and is extremely local, occurring at an altitude of 1600 to 2800 feet. All the young plants observed had pinnatifid leaflets, closely resembling those represented in "Flora Novæ Zelandiæ," Vol. i., pl. 21, but of a purplish hue, *certainly not P. Edgerleyi*. *P. Sinclairii* was not observed.

Schefflera digitata, Forst. The young leaves of this plant, in some of the higher and deeper gullies more especially, are lobulate and pinnatifid to a

much greater extent than is usually the case, often retaining the peculiarity when 3–4 feet high. In some localities, young plants with leaves of the ordinary form are the exception.

Loranthus, n. sp. (?) Widely differing in appearance from any other N. Z. species; branches slender, ascending; leaves erect, decussate, somewhat deltoid, fleshy, yellowish, turning red when dry; flowers not seen, but apparently axillary and solitary; parasitic on *Quintinia serrata*, at an altitude of 1800 to 2700 feet. Occasionally branches of the parasite are adherent to its support for a length of several feet.

Griselinia lucida, Forst., var. *macrophylla*. This is correctly supposed by Dr. Hooker to be merely a state of the species to which it is referred. It is usually found growing on Pohutukawa, and other littoral trees. The normal form is indifferently epiphytic or terrestrial.

Griselinia littoralis, Raoul. Not observed below 1700 feet.

Coprosma, sp. A small shrub 2 feet high, with crimson fruit, apparently allied to *C. linariifolia*, Hook. f., 1800 to 2500 feet.

Raoulia tenuicaulis, Hook. f. Local, but abundant; apparently attains here its northern limit, and that of the genus.

Gaultheria rupestris, Br. Local; from 1700 to 2700 feet; apparently reaches its northern limit here.

Archeria racemosa, Hook. f. Local, but abundant from 1900 to 2800 feet, previously known only on the Great Barrier Island, where it descends below 1000 feet; finds here an extension of its southern range. Leaves distinctly veined, old racemes fully one inch in length.

Dracophyllum Traversii, Hook. f. (?). A remarkable and handsome shrub, of doubtful identification in the absence of flowers; stem erect, stout, simple or sparingly branched; leaves densely aggregated, recurved, 1½ feet long, or more, 1½–2 inches wide at the base; panicle shorter and stouter than in *D. longifolium*, flowers small, crowded. A striking plant although long past flowering. On the highest peaks 2300 to 2700 feet, rare.

Veronica macrocarpa, Vahl. From the sea level to 1800 feet, at the latter altitude having a stature of some 15 feet, or more, with a stem 6 inches in diameter. Mere varieties of *V. salicifolia*, with larger leaves and capsules than usual, are sometimes referred to this handsome species. It is worthy of remark that *V. macrocarpa* flowers from April to July, *V. salicifolia* some months earlier.

Veronica irrigans, Kirk, n. sp. Herbaceous, but branches suffruticose at base, finely puberulous in all its parts, 6–12 inches high, slender; leaves opposite, narrow, linear-lanceolate, distantly sharply serrate, 1–2 inches long, sessile or very shortly petioled; racemes axillary, near the ends of the branches, elongating, 2–5 inches long, very slender, many flowered; peduncles capillary, ¼–½ inch long; sepals ovate, obtuse; flowers, large for the size of the plant, ⅜ inch diameter; petals, whitish with rose-coloured spots at the base; capsules, large, rounded, didymous.

Fagus fusca, Hook. f. The identification of the fine timber tree here referred to this species, rests solely upon a comparison of the foliage. It is certainly identical with the Beech found at the Kawau and at Omaha, and probably with that at Whangarei; but I am not aware that specimens of the inflorescence and fruit have been obtained for comparison with the southern form. At the Thames it is found in rather sheltered places, and has not been found at a greater altitude than 1500 feet. The dense under-growth usually found in the New Zealand forest is entirely wanting in the patches of Beech in the north, and the tree itself is rarely clothed with climbers.

? *Dactylanthus*, sp. A singular plant, provisionally referred to this genus until better specimens can be obtained. Plant, globose, in large specimens,

the size of a man's fist, usually smaller, densely studded with scaly bud-like processes, swollen at the apex, and in a few cases developed to the length of 2 inches. On being laid open, one or two specimens exhibited numerous almost sessile anthers (?), which crumbled under the knife. Most of the specimens collected were in the last stage of decay. Parasitic on the roots of *Schefflera digitata*, 1000 to 1600 feet; rare.

Dacrydium laxifolium, Hook. f., var. An erect branching tree, 30 feet high, of which the inflorescence appears to be quite unknown. Notwithstanding the wide difference in habit, it is referred here chiefly on account of the wide basal attachment of the mature leaves. The leaves of the young state, at first, closely resemble those of *Podocarpus dacrydioides*, subsequently these are replaced by others resembling those of the young state of *Dacrydium cupressinum*, but stouter; these again become gradually smaller, and modified in shape, until the broadly-imbricating appressed state of the mature leaves is finally developed. Alt. 1500 to 2700 feet.

Phyllocladus glauca, Carr. This fine pine attains here an extension of its southern range, and is abundant from 1800 to 2700 feet.

Callixene parviflora, Hook. f. Attains here most probably its northern limit, at an altitude of 2400 to 2700 feet; rare, epiphytic, flowers not seen.

Schœnus Brownii, Hook. f. Local, 700 to 1200 feet, the most northern locality known.

Scirpus triquetur, L. Local, the most northern locality known to me.

Uncinia, sp.? Apparently intermediate between *U. australis*, Pers., and *U. cæspitosa*, Bool., of which last it is possibly a broad-leaved form, allied to the former by the foliaceous bracts.

Hymenophyllum dilatatum, Swartz, and *H. scabrum*, A. Rich. These ferns are most abundant, and attain an unusual luxuriance; fronds over 30 inches in length, were collected at an altitude of 2000 feet.

Trichomanes reniforme, Forst. Also of unusual luxuriance. Ascends from the sea-level to 2700 feet.

Trichomanes strictum, Menzies. From 800 to 2700 feet, but local, although it doubtless occurs in isolated habitats, along the entire peninsula. A careful examination of several hundred specimens of this species, from various localities, as well as of *T. elongatum*, has entirely failed to confirm Mr. Baker's view, of the latter being a variety of the former.

Loxsoma Cunninghamii, Br. Local, but exhibiting a slight extension of its range southward. The most southern locality previously known being at Mercury Bay.

Lomaria elongata, Blume. Descends to about 800 feet, and probably attains here its northern limit; very rare.

Polypodium sylvaticum, Col. This also appears to find its northern limit here; descends to 800 feet.

A few decaying scraps of a plant with narrow-linear leaves, apparently a Clovewort, were picked amongst moss on the peaks of Mount Wynyard, but being without the slightest trace of flower or fruit, identification was impossible. It can scarcely be referred to any described New Zealand species.

Catalogue of the Flowering Plants and Ferns, etc., collected on the Thames Gold-fields, March and April, 1869.

It is attempted in the following catalogue, to arrange the Phænogamic plants and higher Acrogens of the Cape Colville Peninsula, so as to afford as definite an idea of the distribution of each species, as the space at command will admit of. The method adopted requires a few words of explanation.

The plants are arranged in groups, according to the nature of their habitats, viewed chiefly with regard to dryness, moisture, shade, exposure, etc.

In this district they may be roughly divided into, Ericetal, or plants of the open land, and Sylvestral, or woodland plants, which would almost equally divide the total number of plants between them. The first of these divisions readily admits of sub-division, and the following terms have been adopted for the different groups.

* 1. Littoral. Plants of the sea-shore, whether growing on sandy or muddy beaches, as *Convolvulus Soldanella, Salicornia indica:* on sea-cliffs, as *Metrosideros tomentosa;* or in salt-marshes, as *Juncus maritimus.*

2. Ericetal. Plants of open dry land, as *Leptospermum scoparium, Pteris esculenta.*

3. Pascual. Plants of open grassy land, as *Ranunculus plebeius, Cardamine hirsuta.*

4. Rupestral. Plants growing on or amongst rocks, as *Cheilanthes Sieberi, Pellœa rotundifolia.*

5. Viatical. Plants growing in waste places, or by road sides, etc., as *Polygonum aviculare, Agrostis æmula.*

6. Inundatal. Plants growing on the banks of streams, or in other places liable to frequent inundation, as *Oxalis magellanica, Pratia angulata, Lomaria lanceolata.*

7. Paludal. Plants growing in constantly wet soil, or in water, as *Epilobium pallidiflorum, Typha latifolia.*

8. Lacustral. Aquatic plants, whether floating or submerged, as *Ranunculus rivularis, Zostera marina.*

9. Sylvestral. Forest or woodland plants, as *Dammara australis, Nesodaphne Tawa, Microlœna avenacea.*

There are a few plants whose habitats are so varied, or possibly so complex, that they cannot be fully expressed by a single term; thus *Cardamine hirsuta* might with almost equal propriety be classed as Pascual or Sylvestral. *Nasturtium palustre* as Inundatal or Viatical. *Podocarpus dacrydioides* as Sylvestral or Paludal. *Muhlenbeckia complexa* as Ericetal or Sylvestral.

In these and a few other other cases, some allowance must of necessity be made on the score of conciseness.

The term "Sylvestral" is perhaps the most open to objection, on account of its comprehensiveness, as no distinction is drawn between plants found only in deep forests, as the Kauri, and those found in light scrub, or on the outskirts of forest, as the various species of Clematis; but the degrees of difference are generally so near that it is extremely difficult to define them, and to adopt terms that can be applied with any approach to precision. The attempt has therefore been abandoned for the present.

To a certain extent, the above arrangement gives a definite idea of the distribution of each species; but by the aid of a short series of numbers, greater precision may be gained. The series adopted is 1, 2, 3, 4, 5, 10, 15, 20. A plant with the highest number affixed, is one of the most generally distributed throughout the district, limited only by the nature of its habitat, and (possibly) by altitude. Thus Geniostoma is found in, or on, the margin of almost every patch of bush, however small, as is *Leptospermum scoparium* on every open hill-side. The lower numbers exhibit comparative rarity. But it must be borne in mind that this notation has reference to the extent of distribution only, and not to relative abundance. The same number is applied to each of the two plants last mentioned, yet if the relative number of individuals could be compared, it would be found less than a single plant of the Geniostoma to ten thousand of the Leptospermum. At the advanced

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* These terms are similar to those introduced by Mr. Watson, in his various works on Phytogeography, but are employed with different limitations.

period of the season at which the survey was made, it was only possible to apply this test of frequency to a portion of the plants observed.

The estimate of altitude affixed to many species, is chiefly based upon single observations with a pocket aneroid, and can therefore be regarded as approximative only.

It may well be, that from the late period of the season at which this exploration was made, some plants will be found to be omitted from the list, and the distribution of others but imperfectly laid down from the same cause. The application of the terms and figures descriptive of habitat, frequency, and vertical range, must be regarded as for this district only.

I.—Littoral.

Lepidium oleraceum. Pittosporum crassifolium, (1). P. umbellatum, (3). Plagianthus divaricatus, (3). Linum monogynum, (5). Oxalis corniculata, (20).* Pomaderris Edgerleyi, (2) —200. Metrosideros tomentosa, (15) —2000. Mesembryanthemum australe, (10). Apium australe. A. filiforme. Panax Lessoni, (5)† —800.? Coprosma Baueriana, (1). Olearia furfuracea, (2). O. albida, (5) —200. Senecio lautus, —1000. Selliera radicans. Samolus repens. Convolvulus Soldanella. Avicennia officinalis, (4). Chenopodium ambiguum. Salicornia indica. Euphorbia glauca. Astelia Banksii, —800. Juncus maritimus. Leptocarpus simplex. Scirpus maritimus. S. triquetur. Desmochœnus spiralis. Carex pumila. Spinifex hirsutus. Paspalum distichum. Dichelachne stipoides. Triticum multiflorum. T. scabrum. Asplenium obtusatum.

II.—Ericetal.

Geranium microphyllum. Pomaderris phylicifolia, —1000. Coriaria ruscifolia, (20) —2000. Drosera auriculata, —2000. Haloragis tetragyna. Leptospermum scoparium, (20) —2000. Lagenophora Forsteri, (20). Wahlenbergia gracilis. Gaultheria antipoda, (15) —2000. Epacris pauciflora, (4) —300. Leucopogon Frazeri, (5). Dracophyllum squarrosum, (4) —2300. Geniostoma ligustrifolium, (20). Muhlenbeckia complexa, (10). Pimelia prostrata. Acianthus Sinclairii, —2000. Microtis porrifolia. Thelymitra longifolia. Orthoceras Solandri. Cordyline Banksii, (10). C. Pumilio, (10). Dianella intermedia, (10). Schœnus tenax. S. tendo. Gahnia setifolia. G. arenaria. Carex breviculmis. Lindsæa linearis, (4). Pteris esculenta, (20) —2520. Doodia media, (10). Schizæa bifida, (5) —2000. Botrychium cicutarium, (3). Lycopodium densum, (15) —2000. L. volubile, (20) —2000.

III.—Pascual.

Ranunculus plebeius, (20). Cardamine hirsuta. Linum marginata. Haloragis micrantha. Epilobium Billardierianum. Dichondra repens. Plantago Raoulii. Libertia ixioides. Arthropodium candidum. Luzula campestris. Microlæna stipoides. Dichelachne sciurea. D. crinita. Agrostis quadriseta. Danthonia semi-annularis, —2000. Poa anceps.

IV. Rupestral.

Epilobium nummularifolium, (20). E. pubens. Celmisia, sp. (1), 2200–2700. Ozothamnus glomeratus, (3) —1600. Erechtites scaberula, E. quadridentata. Gaultheria rupestris, (1) 1700–2700. Convolvulus

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* The typical form is a truly Littoral plant: the varieties are Ericetal and Viatical.

† Also Sylvestral.

Note.—Range in altitude given in feet: a dash only, prefixed, signifies "from sea-level to." Figures in parentheses refer to the comparative distribution of species in the district: see p. 96.—Ed.

Tuguriorum. Parietaria debilis. Peperomia Urvilleana. Earina autumnalis. Arthropodium cirrhatum (5). Microlæna polynoda. Echinopogon ovatus. Cheilanthes Sieberi, (3). Pellæa rotundifolia (10). Lomaria vulcanica, (2) 1200–1800. Asplenium lucidum, (20). A. flabellifolium, (3). A. Hookerianum (3) —1600. Aspidium Richardi, (20). Schizæa fistulosa, (3) —2000. Lycopodium scariosum, (3) —2000.

V. VIATICAL.

Geranium dissectum, vars. carolinianum, pilosum, patulum, glabratum. G. molle. Pelargonium australe, var. clandestinum. Acæna Sanguisorbæ. Haloragis alata. Epilobium junceum, (20). Sicyos angulatus. Daucus brachiatus. Bidens pilosa. Cotula australis. Gnaphalium luteo-album. G. involucratum. G. collinum. Sonchus oleraceus, var. asper. Convolvulus sepium. C. marginata. Solanum aviculare. S. nigrum. Polygonum aviculare. Rumex flexuosus. Agrostis æmula. A. Billardieri.

VI.—INUNDATAL.

Nasturtium palustre. Viola filicaulis, (1) —700. Stellaria parviflora. Oxalis magellanica. Gunnera monoica. Callitriche Muellerii. Eugenia Maire, (5). Epilobium alsinioides. Hydrocotyle elongata. H. moschata. Coprosma propinqua (?), (5). C. linariifolia, (5). Olearia Solandri. Lagenophora petiolata. Cotula perpusilla. C. minuta. Raoulia tenuicaulis. Gnaphalium Keriense. Lobelia anceps. Pratia angulata. Veronica irrigans, Kirk, n. sp., —300. Corysanthes rivularis. C. macrantha. Triglochin triandrum. Cordyline australis. Astelia grandis. Phormium tenax, —2300. P. tenax, var. variegata. P. Colensoi. Juncus vaginatus. J. bufonius. Schœnus Brownii, 700–1200. Isolepis nodosa. I. riparia. Cladium Gunnii. C. Sinclairii. Carex lucida. C. Lambertiana. C. vacillans. Sporobolus elongatus. Gleichenia circinata, (5). G. circinata, v. hecistophylla. Dicksonia squarrosa, —2000. Loxsoma Cunninghamii. Lindsæa trichomanoides, (2). Lomaria membranacea, (10). L. lanceolata, (15). Lycopodium cernuum, (5).

VII.—PALUDAL.

Hypericum japonicum. Epilobium tetragonum. E. pallidiflorum. Hydrocotyle asiatica. Nertera Cunninghamii, (3). Cotula coronopifolia. Polygonum minus, var. decipiens. Typha latifolia. Juncus planifolius. Schœnus axillaris. Eleocharis acuta, var. platylepis. E. gracillima. Isolepis prolifer. Cladium glomeratum. C. teretifolium. C. junceum. Carex virgata. C. virgata, var. secta. C. Gaudichaudiana. C. ternaria. C. Forsteri. Isachne australis. Arundo conspicua. Lomaria procera, (20) —2600. L. fluviatilis, (5) 500–1600. L. elongata, (1) —800. Lycopodium laterale, (3).

VIII.—LACUSTRAL.

Ranunculus rivularis. (Fluviatile.) Zostera marina. (Marine.)

IX.—SYLVESTRAL.

Clematis indivisa, (10). C. parviflora, (3). C. fœtida, (3). C. Colensoi, (2). Drimys axillaris, (5) —2000. D. colorata, (2). Cardamine stylosa. Melicytus ramiflorus, (20) —2000. M. micranthus, (5). Pittosporum tenuifolium, (20). P. Huttonianum, Kirk., n. sp., (5), under 500. P. Eugenioides, (10). P. cornifolium, (15) —2000. P. Kirkii, Hook. f., n. sp., (3) 1600–2700. Hoheria populnea, (5). Entelea arborescens, (10). Aristotelia racemosa, (15). Elœocarpus dentatus, (20). E. Hookerianus, (1) 2000–2700. Phebalium nudum, (5) —2000. Melicope ternata, (10). M. simplex, (5). Dysoxylum spectabile, (15). Dodonæa viscosa, (15). Alectryon excelsum, (10). Cory-

nocarpus lævigata, (20). Carmichælia australis, (10). Sophora tetraptera, (15). Rubus australis, vars. glaber, schmidelioides, cissoides, (20). Quintinia serrata, (15) —2700. Ixerba brexioides, (10) 800–2700. Carpodetus serratus, (10) —1800. Weinmannia silvicola, (20) —2500. W. racemosa, (3). Leptospermum ericoides, (10). Metrosideros florida, (15) —2400. M. lucida, (10) 1700–2700. M. albiflora, (5) 900–2700. M. hypericifolia, (15). M. robusta, (15) —2500. M. robusta, var. M. scandens, (20). M. diffusa. Myrtus bullata, (10). Fuchsia excorticata, (20). Passiflora tetrandra, (10). Panax Edgerleyi, (10) 1000–1800. P. crassifolia, (20) —2500. P. Colensoi, (2) 1800–2700. P. arborea, (20) —2500. P. arborea, var. P. n. sp. (5) 1800–2700. Schefflera digitata, (15) —2500. Griselinia lucida, (20) —2000. G. lucida, v. macrophylla. G. littoralis, (4) 1700–2700. Corokia buddleoides, (4) —2300. Loranthus, n. sp., (3) 1700–2700. L. micranthus, (4). Tupeia antarctica, (5). Alseuosmia macrophylla, (20) —2700. A. macrophylla, var. variegata. A. quercifolia, (3). Coprosma lucida, (15) —2300. C. lucida, var., 1800–2700. C. grandifolia, (15) 2500. C. robusta, (15). C. spathulata, (5). C. rotundifolia. C. sp., (2) 2000–2500. Nertera dichondræfolia, — 2000. Olearia Cunninghamii, (20). Senecio glastifolius, (15) —2700. Brachyglottis repanda, (20) —2500. Cyathodes acerosa, (10) —2300. Leucopogon fasciculatus, (20) —2500. Archeria racemosa, (2) 1800–2700. Dracophyllum Traversii, (2) 2300–2700. D. latifolium, (5) —2000. Myrsine salicina, (3). M. Urvillei (15) —2000. M. divaricata, (1). Olea Cunninghamii, (2). O. lanceolata, (5). Parsonsia albiflora, (20) —2500. Veronica salicifolia, (20). V. macrocarpa, (4) —1800. Rhabdothamnus Solandri, (15) —2000. Vitex littoralis, (10). Myoporum lætum, (5). Muhlenbeckia adpressa, (10). Tetranthera calicaris, (10). Nesodaphne Tarairi, (2) —800. Nesodaphne Tawa, (15) —2000. Atherosperma Novæ Zelandiæ, (5). Hedycarya dentata, (10). Knightia excelsa, (15) —2000. Persoonia Toro, (10), —2700. Pimelea longifolia, (2) 1200–1800. P. virgata, (4). Santalum Cunninghamii, (10) —2000. Fagus fusca, (5) —1500. Epicarpurus microphyllus, (3). Piper excelsum, (15). ? Dactylanthus, sp. Dammara australis, (20) —2700. Podocarpus ferruginea, (10). P. Totara, (15) —2700. P. spicata, (5). P. dacrydioides, (5). Dacrydium cupressinum, (10) —2000. D. laxifolium, (3) (tree form) 1800–2700. Phyllocladus trichomanoides, (15) —2000. P. Glauca, (3) 1800–2700. Earina mucronata. Bolbophyllum pygmæum, —2500. Sarcochilus adversus. Adenochilus gracilis. Corysanthus triloba,—1600. C. rivularis. Pterostylis Banksii. P. trullifolia, —1200. Libertia micrantha, 1000–2700. Freycinetia Banksii, (20) —2500. Rhipogonum scandens, (15) —2500. Callixene parviflora, 2400–2700. Astelia Cunninghamii, (10) —2500. A. Solandri, (20)—2700. Astelia, n. sp., (15)—2700. Areca sapida, (15). Gahnia, n. sp. G. ebenocarpa. G. lacera, —2700. Uncinia australis. U. sp. U. Banksii. Microlæna avenacea. Panicum imbecille. Gleichenia Cunninghamii, (5). Cyathea dealbata, (15) —2000. C. medullaris, (20) —2000. C. Smithii, (10) —2700. Dicksonia lanata, (2) 1200–1800. Hymenophyllum Tunbridgense, (10) —2500. H. bivalve, (1), 1500–1900. H. multifidum, (10) —2700. H. rarum, (10) —2500. H. dilatatum, (20) —2500. H. Javanicum, (10) —1500. H. sanguinolentum, (20)—2700, H. demissum, (20) —2000. H. scabrum, (15) —2000. H. flabellatum. (20) —2500. H. æruginosum, (10) —2000. H. Lyallii, (10) —2700, Trichomanes reniforme, (20) —2700. T. strictum, (4) 800–2700. T. elongatum, (15) —1800. T. humile, (10) —1800. T. venosum, (10) —1800. Davallia Novæ Zelandiæ, (2) 800–1500. Lindsæa Lessonii, (5) —2000. Adiantum hispidulum, (5). A. affine, (5). A. Cunninghamii, (20). A. fulvum, (15). Hypolepis tenuifolia, (10). Pteris tremula. (20) —2700. P. scaberula, (5). P. incisa, (5). P. macilenta, (15). P.

Endlicheriana, (5). Lomaria filiformis, (10) —2000. L. discolor, (10). L. nigra, (3) 1800–2500. L. Fraseri, (10). Asplenium falcatum, (20) —2000. A. bulbiferum, (20). A. flaccidum, (20) —2000. Aspidium coriaceum, (15). Nephrodium velutinum, (20). N. decompositum, (10). N. de., var. pubescens. N. hispidum, (15). Polypodium australe, (10) —2700. P. Grammitidis, (15) —2500. P. tenellum, (2). P. sylvaticum, (3) 800–1700. P. rugulosum, (5). P. pennigerum, (20). P. rupestre, (15) —2500. P. Cunninghamii, (20) —2500. P. pustulatum, (20) —2000. P. Billardieri, (20) —2500. Leptopteris hymenophylloides, (20). Lygodium articulatum, (15) —2500. Lycopodium Billardieri, (15)—2500. Tmesipteris Forsteri, (15) —2700.

NATURALIZED PLANTS.

Nasturtium officinale. Erysimum officinale. Senebiera pinnatifida. Capsella Bursa-pastoris, Sinapis arvensis. Brassica rapa. B. napus. B. oleracea. Raphanus sativus. Vitis vinifera. Silene quinquevulnera. Stellaria media. Cerastium vulgatum. C. viscosum. Malva rotundifolia. M. Caroliniana. Erodium circutariam. Trifolium repens. T. pratense. T. medium. T. procumbens. T. minus. Melilotus arvensis. Medicago lupulina. M. maculata. M. denticulata. Acacia lophantha. Amygdalus persica. Prunus cerasus. Fragaria elatior. Rubus Idæus. Rosa micrantha. R. rubiginosa. R. multiflora. Œnothera stricta. Cucurbita, sp. Erigeron canadensis. Bellis perennis. Senecio vulgaris. Carduus lanceolatus. Hypochœris radicata. Taraxacum Dens-Leonis. Helminthia Echioides. Anagallis arvensis. Solanum tuberosum. Physalis peruviana. Verbascum, sp. Veronica arvensis. V. serpyllifolia. Mentha viridis. Prunella vulgaris. Plantago major. P. lanceolata. Rumex viridis. R. obtusifolius. R. crispus. R. Acetosella. Chenopodium murale. Euxolus viridis. Euphorbia Peplus. Riccinus Palma-Christi. Ficus Carica. Colocasia antiquorum. Iris Germanica. Allium, sp. Alopecurus pratensis. Phalaris canariensis. Holcus mollis. H. lanatus. Anthoxanthum odoratum. Digitaria sanguinalis. Poa annua. P. pratensis. Briza minor. Dactylis glomeratus. Bambusa arundinacea. Lolium perenne.

Art. XVI.—*An account of the* Puka (Meryta Sinclairii, *Seem.*) By T. Kirk.

[*Read before the Auckland Institute, June* 7, 1869.]

This rare plant was originally discovered at the head of Whangururu Bay by Mr. Colenso, who sent specimens of the foliage to Kew; specimens from the same locality were forwarded also by the late Dr. Sinclair, to whom it was pointed out by Mr. Colenso, and these appear to have formed the only material for the original description of the plant by Dr. Hooker, in the "Flora Novæ Zelandiæ," under the name of *Botryodendrum Sinclairii.* Only a single tree was found, which was protected by a fence, and tabued by the natives, by whom it was stated to have been brought from the Poor Knights' Islands, and who were greatly astonished at Mr. Colenso's frequent visits to the locality, during several successive years, in the vain hope of procuring flowers and fruit.

Mr. William Mair subsequently found the tree, and after several visits succeeded in procuring specimens of the leaves and fruit, which were given by him to Dr. Sinclair, who forwarded them to Dr. Hooker at Kew, and from these specimens the still-imperfect description in the "Handbook of the New Zealand Flora," was drawn.

At a later date, Dr. Sinclair again visited the locality, and found that the

tree,—the only one known to Europeans prior to the recent discovery—had been cut down.

In a recent visit, made in company with Captain Hutton to the Taranga Islands, specially to search for the Puka, I had the good fortune to find a few trees in various stages of inflorescence and fruit, and have drawn up the following notes, illustrative of the specimens now exhibited from that locality.*

The Puka differs (so far as is known) from other members of the genus Meryta, in its strictly diœcious character, all the other species being described as polygamous. It is a small tree, attaining the height of from twelve to twenty-five feet; trunk, stout or slender, irregularly and sparingly branched; bark, dark-brown, with numerous warty excrescences; branches, very stout, showing the scars of fallen leaves; leaves, densely crowded, twenty to thirty together, at the tips of the branches, with a few large deciduous scales amongst the petioles of the youngest, 9″ to 30″ long (including the petioles), 4″ to 10″ wide, very coriaceous, obovate-oblong, rarely oblong, usually contracted below the middle, with stout lateral veins, margin slightly waved, with a few large crenatures, the whole edged with a remarkable marginal nerve; petioles, stout, 4″–14″ long, with a broad attachment, irregularly striated, not jointed with the blade. Panicles, stout, terminal, much branched, from 8″–16″ long, branches jointed. Male—Primary branches about eight, more slender than in the female; secondary branches 1″–3″ long, flowers sessile, crowded in tetramerous clusters, with an ovate bract at the base of each cluster, and two minute bractlets below each flower; sepals, 4-valvate, ligulate, ultimately somewhat flexuose, petals 0; stamens, 4 inserted beneath a corrugated glandular disk, anthers lobed, oblong. Female—Stouter and shorter than in the male, branches crowded, primary branches 10–15; flowers solitary or crowded, with a bullate, notched bract at the base of each; ovary ovate, with 3–6, usually 4–5, stigmas, united below, tips recurved, staminodia invariably present. Fruit roundish-oblong, black, shining, slightly angled when young, becoming even as it approaches maturity; seeds 5, curved, much compressed, about three-eighths of an inch in length, black, or dark-brown, intensely hard.

The entire plant is more or less resinous, and the bark is easily wounded, producing large callosities as it heals, wood white and brittle. Not more than eight plants were observed, of which six were in various stages of flower and fruit. These grew in situations fully exposed to the violent south-westerly gales, but owing to the remarkable marginal nerve, not a leaf was found torn or injured in any way; in this respect presenting a strong contrast to *Pisonia umbellifera*, which grew with it, and of which scarcely a leaf could be found entire; in fact the external leaves were often torn into shreds from the violence of the wind.

It is not unlikely that a true Botryodendrum may be found on the Kermadec Islands, and it would be highly interesting to ascertain if our plant is found on the Three Kings' group, of the botany of which we are entirely ignorant. The Puka must, in any case, be considered one of the rare plants of the world. As far as we have seen, the solitary plant found on the main land was not indigenous; and it is only known to Europeans in the locality now placed on record. Its existence upon the Poor Knights' rests solely upon Maori authority, and it is known not to be found in an indigenous state on the Fanal Islands, or on the Kawau. The only unsearched localities in which there is even a slight probability of its occurrence, are the north-west side of the Little Barrier, and the Three Kings.

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* I was unable to obtain good drawings from the recent specimens, owing to their having been spoiled by sea-water, from exposure in an open boat during a severe gale on our return.

It is a matter for congratulation that the plant is already established under cultivation, as the specimens found at the Taranga Islands grow in situations where they are peculiarly open to destruction.

The Maoris at Ohora stated that they, some years back, planted a young tree on one of the Fanal Islands, which is still living although it has grown but little.

ART. XVII.—*On* GRASSES AND OTHER PLANTS *adapted for pasturage in the Province of Auckland, especially with regard to indigenous kinds.* By T. KIRK.

[*Read before the Auckland Institute, August* 16, 1869.]

So few kinds of grasses have yet been made subservient to pastoral purposes in this province, that a difficulty presents itself at the outset, not in finding kinds likely to prove of permanent value, but in making a judicious selection from those of proved value in other countries, and from those which are truly indigenous to the colony. Rye-grasses (*Lolium perenne* and *L. italicum*), meadow-grass (*Poa pratensis*), timothy (*Phleum pratense*), round cocksfoot (*Dactylis glomerata*), sweet-vernal (*Anthoxanthum odoratum*), with the common red and white clovers (*Trifolium pratense* and *T. repens*) in variety, comprise the kinds usually cultivated. The black medick, spotted medick, and toothed medick (*Medicago lupulina*, *M. maculata*, and *M. denticulata*), which afford such an abundance of grateful food on some of our volcanic hills and waste places; the dogs-tail (*Cynosurus cristatus*), the common bent grass (*Agrostis vulgaris*), the soft brome grass (*Bromus mollis*), and others naturalized in many places do not appear to have attracted the attention of the agriculturist, although amongst the commonest of cultivated grasses in Europe. Nor have the available native grasses been brought under cultivation, notwithstanding the avidity with which certain kinds are sought after by cattle, a fact which ought, long ere this, to have drawn attention to their cultural value, the more especially from their being less subject to the attacks of caterpillar than most of the introduced kinds. Still less has any attention been paid to the many valuable plants possessing condimental properties, stimulant and aromatic, such as the burnet (*Sanguisorba officinalis*), burnet saxifrage (*Pimpinella Saxifraga*), stone parsley (*Petroselinum segetum*), fenugreek (*Trigonella Fœnum-Græcum*), yarrow (*Achillæa millefolium*), which form so large a portion of nearly all natural pastures, and which are so eagerly devoured by all kinds of cattle. But, in truth, the attention of the most advanced agriculturists has been directed too exclusively to grasses and clovers as pasturage plants, and it is mainly owing to the ravages of the terrible rinder-pest, which has caused greater attention to be turned, amongst other things, to the green food of cattle, that these condimental plants have been brought into prominent notice.

If we examine a piece of natural pasture, such as the sheep-downs of the south of England, we find a close compact growth of various fine-leaved sheeps' fescue grasses, small-growing meadow-grasses, bent-grasses, dogs-tail grass, with numerous small trefoils, and medicks, and especially, with dwarfed plants of burnet-saxifrage, stone-parsley, yarrow, and other stimulant or aromatic plants, which furnishing an agreeable variety to the sheep feeding upon them, are greedily sought after. In richer lands the small sheep-fescues, and meadow-grasses, are replaced by the various meadow-fescues, and the larger meadow grasses, with foxtail, catstail, red and white clovers, black and spotted medicks, cowparsley, mayweed, burnett, and others. The grasses are rarely found alone. Even in the natural pasture of the southern parts of New

Zealand, the grasses are largely mixed with native species of Angelica, Mentha, Dichondra, Lepidium, Nertera, Epilobium, and Oxalis, with many dwarf-growing shrubs.

No attempt has been made, at least so far as I am aware, to utilize the swamps and swampy gullies so common in many parts of the province, or to add introduced kinds to those often found indigenous to such localities. In many places where drainage would be impracticable, or too costly for the means at command, a large crop of nutritious grasses, suitable either for green or dry fodder, might be obtained at little more than the cost of the seed, by the selection of suitable kinds, such as the orange-spiked foxtail (*Alopecurus fulvus*), the reed-canary grass (*Phalaris arundinacea*), the meadow-sweet grass (*Glyceria aquatica*), the floating meadow grasses (*Glyceria fluitans* and *G. plicata*), the broad-leaved meadow grass (*Poa sudetica*), or the native swamp grasses (*Hierochloe redolens* and *Isachne australis*), the last being one of the most valuable grasses in the colony. It is obvious that a resource like this is of great value to the newly-located settler of small means, who too often sees his first paddocks fail when most needed, from badly-selected seeds, or the ravages of caterpillar. How many cases of actual failure might have proved ultimate success, had this simple resource been known!

I purpose briefly indicating the principal introduced and native plants adapted for pasturage in this province. It must not however be supposed that the catalogue is intended to be exhaustive. Of the native kinds, only those decidedly preferred by cattle in this province, are mentioned; other forms, especially some of the sub-alpine meadow-grasses, form favourite food in the south.

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[Mr. Kirk then describes the characters and qualities of foreign grasses suitable for New Zealand soils, which are classfied in the lists appended to his paper.—Ed.]

NEW ZEALAND GRASSES,

ALL OF WHICH ARE FOUND IN THIS PROVINCE, AND ARE MORE OR LESS EATEN BY CATTLE.

Microlæna stipoides, Br. A slender-growing social grass, apparently confined to the North Island; closely cropped by sheep, horses, and cattle. In many places it is found growing with *Danthonia semi-annularis*, and the introduced sweet vernal grass and yellow suckling, forming patches of nutritious pasture amongst the Tea-tree. In several localities near Auckland, these four plants, probably self-seeded, form a large portion of the vegetation of the paddocks.

Microlæna avenacea, Br. A coarse-growing kind, common in woods where few other kinds will grow. Eaten by cattle and horses.

Hierochloe redolens, Br., "Karetu." Common in wet places and swamps, of rather stout habit but sweet and succulent, eaten by horses and cattle. In Mr. Buchanan's "Sketch of the Botany of Otago," it is considered a grass of the first quality; it appears however to be inferior to *Microlæna stipoides*, which is not found in the South Island.

Isachne australis, Br. Abundant in moist places, swamps, and by river sides, from the North Cape to Waikato, and perhaps much further south. A slender-growing grass, producing a large yield, and eaten with avidity by sheep, horses, and cattle. Certainly one of the most valuable of our native grasses, and would most likely prove an addition to the cultivated grasses of the warmer parts of Europe: a native of Australia, India, and China.

Zoysia pungens, Willd. A small creeping rooted grass, forming a compact turf in places near the sea; it has been observed on sand, mud, and the dry

debris of trachytic rocks; eaten by cattle and sheep, and would probably form pasturage of considerable value for the latter, as the herbage, though short, is sweet and succulent.

Dichelachne stipoides, Hook. f. Common on rocky and waste places and pastures, especially near the sea. Eaten by cattle and horses; in Otago it is ranked in value with *Hierochloe redolens*.

Agrostis æmula, Br. A slender bent-grass, found throughout the islands, eaten alike by sheep and cattle, especially in the young state.

Danthonia semi-annularis, Br. A variable grass found in nearly all soils and situations throughout the colony. Eaten by sheep, horses, and cattle. In Otago considered a good cattle-grass. (See the notes under *Microlæna stipoides.*)

Trisetum antarcticum, Trin. A valuable pasture grass, deservedly considered by Buchanan as a grass of the first quality, for moist pastures; it will probably prove of greater value than the yellow oat-grass of Europe, to which it is closely allied.

Poa breviglumis, Hook. f. A "meadow-grass," producing a large quantity of nutritious herbage; eaten by sheep, cattle, and horses; found in various localities throughout the islands, especially near the sea; but apparently less common in Auckland than in Canterbury and Otago, where it is considered a grass of the first quality.

Poa anceps, Forst. An excessively variable "meadow-grass," common throughout the islands, and ascending the mountains to the height of fully 6000 feet. One of its forms growing in swampy woods might easily be mistaken for the common meadow-grass of Europe. Eaten by all kinds of cattle, and produces an abundant crop; frequently found in pastures, especially near the sea. It is probable that some forms of this variable grass are of greater value than others.

Poa australis, Br. var. *lævis*. A meadow-grass of more slender habit than the last, not common in the north, but avidly sought after by sheep, horses, and cattle. A pasturage of great value, and deservedly ranked of the first quality by Buchanan.

Triticum multiflorum, Banks. and Sol.

Triticum scabrum, Br. Not so common in the North Island as in the South, where it is abundant, ascending the mountains to the height of 6000 feet, and is ravenously eaten by all kinds of cattle.

Helosciadium leptophyllum, A.D.C. A small umbellate plant recently discovered in this island; is greedily eaten by sheep, cattle, and horses; apparently aromatic.

There are reasons for supposing that the time requisite for bringing the different species to maturity is somewhat less than would be required in the British Islands, although not in the same ratio for each species. This interesting point can only be fully determined by a series of observations, extending over several seasons. In selecting grasses for the yield of hay alone, it must be remembered that while the majority yield the best return of hay, both with regard to quality and quantity, at the commencement of, or just prior to, their coming into flower, others, as the rough meadow-grass (*Poa trivialis*, L.), are most profitable when the seed is ripe, and others, again, as the bent-grasses, yield the heaviest return some time before flowering.

The following selections are based chiefly on soil or situation.

Grasses suitable for ordinary Loamy Soils.

[Grasses indigenous to this Province (Auckland), are marked with an Asterisk.]

**Microlæna stipoides*. *Alopecurus pratense*, Foxtail. *Phleum pratense*, Timothy. * *Agrostis æmulu*. *Anthoxanthum odoratum*, Sweet vernal.

* *Trisetum antarcticum.* *Arrhenatherum avenaceum.* *Danthonia semi-annularis.* *Poa pratensis,* Common meadow. *P. sudelica,* Broad-leaved meadow. *P. serotina,* Late-flowering meadow. *Dactylis glomerata,* Round cocksfoot. *Cynosurus cristatus,* Dogsfoot. *Festuca pratensis,* Meadow fescue. *F. loliacea,* Darnel-leaved fescue. *F. duriuscula,* Sheep's hard fescue. *Bromus mollis,* Soft brome. *Lolium perenne,* var., Pacey's perennial. *Medicago lupulina,* Black medick. *Trifolium repens,* White clover. *T. pratense,* Red clover. *T. elegans,* Slender clover. *Poterium sanguisorba,* Salad burnet. *Bunium flexuosum,* Earthnut. *Achillea millefolium,* Yarrow. *Pimpinella magna,* Large burnet saxifrage. *Plantago lanceolata,* Rib grass.

For Swamps, Water meadows, etc.

Alopecurus fulvus, Orange spiked foxtail. *Phleum pratense.* *Phalaris arundinacea,* Reed Canary. * *Isachne australis.* *Agrostis alba,* White bent-grass. * *A. quadriseta.* * *Hierochloe redolens.* * *Poa anceps.* *P. sudetica.* *Glyceria aquatica,* Water sweet. *G. fluitans,* and *G. plicata,* Floating meadow. *Festuca elatior,* Tall meadow fescue. *F. loliacea.* *Lolium perenne,* var. Pacey's perennial rye. *Trifolium repens.* *T. pratense.* *Lotus major,* Water birdsfoot trefoil. *Plantago lanceolata.*

For Clay Soils.

* *Microlæna stipoides.* *Alopecurus pratense.* *Phleum pratense.* *Agrostis stolonifera,* Fiorin. *Anthoxanthum odoratum,* Sweet vernal. *Arrhenatherum avenaceum.* * *Danthonia semi-annularis.* *Poa sudetica.* *P. pratensis.* **P. anceps.* **P. australis.* *Dactylis glomerata.* *Festuca loliacea.* *F. duriuscula.* *Bromus erectus,* Upright Brome. *Lolium perenne,* var. *Medicago lupulina.* *Trifolium repens.* *T. pratense.* *T. pratense,* var. *hybridum.* *T. elegans.* *Sanguisorba officinalis,* Burnet. *Petroselinum sativum,* Parsley. *Carum carui,* Carraway. *Achillea millefolium.*

For Sandy and Gravelly Soils.

**Agrostis æmula.* *Anthoxanthum odoratum.* *Trisetum flavescens,* Yellow oat. * *T. antarcticum.* *Poa pratensis.* *P. nemoralis.* **P. breviglumis.* **P. australis,* var. *lævis.* *Dactylis glomerata.* *Cynosurus cristatus.* *Festuca pratensis.* *F. duriuscula.* *F. ovina,* Sheep's fescue. *F. rubra,* Red sheep's fescue. *Lolium perenne,* var. *Lotus corniculatus,* Birdsfoot trefoil. *Trifolium medium,* Zigzag clover. *T. repens.* *T. striatum,* Soft clover. *T. procumbens,* Hop trefoil. *Trigonella Fœnum-Græcum,* Fenugreek. *Medicago lupulima.* *Pimpinella saxifraga,* Common burnet saxifrage. *Poterium muricatum,* Pitted salad burnet. *Petroselinum segetum,* Stone parsley. *Achillea millefolium.*

For Forest Land, after Clearing.

* *Microlæna stipoides.* *Phleum pratense.* *Milium effusum,* Wood millet. *Anthoxanthum odoratum.* *Trisetum flavescens.* *Arrhenatherum avenaceum.* * *Danthonia semi-annularis.* *Poa pratensis.* **P. breviglumis.* * *P. anceps.* *Dactylis glomeratus.* *Festuca loliacea.* *F. duruiscula.* *Lolium perenne,* var. *Trifolium repens.* *T. striatum.* *T. pratense.* *Medicago lupulina.* *Poterium muricatum,* Pitted salad-burnet. *Bunium flexuosum.* *Pimpinella magna.* *Achillea millifolium.*

For Woods.

* *Microlæna stipoides.* * *M. avenacea.* *Milium effusum.* *Poa nemoralis.* *P. trivialis.* *Pimpinella magna.* *Trifolium elegans.* * *Apium leptophyllum.*

For Dry and Rocky Places accessible to Sheep.

Cynosurus cristatus, Dogsfoot. *Poa compressa,* Flat-stemmed meadow. * *Agrostis æmula.* * *A. Billardieri.* * *Danthonia semi-annularis.* *Festuca rubra.* *F. ovina.* *Medicago lupulina.* *M. denticulata.* *Petroselinum sativum.* *Pimpinella saxifraga.* *Poterium muricatum.* *Achillea milifolium.*

FOR SANDY AND MUDDY PLACES:
(ESPECIALLY NEAR THE SEA.)

* *Zoysia pungens.* **Poa breviglumis.*

FOR PLACES OCCASIONALLY OVERFLOWED BY THE SEA.

Sclerochloa distans, var. *obtusa. S. maritima.*

FOR PLANTING ON CLAY SOILS, AMONGST MANUKA, ETC.

Stenotaphrum glabrum, Buffalo grass.

It may safely be asserted that the best pastures in the province would be improved by a mixture of some of the condimental plants mentioned, say at the rate of 3 ℔s. of seed to the acre, or 2 ℔s., if a large proportion of yarrow is used, with a few pounds of such of the fescues and meadow-grasses as may be best adapted to remedy existing defects.

There is little doubt that superior varieties of the best of these grasses—forms more closely adapted to our precise requirements than anything we at present possess—will be obtained with comparatively little difficulty, when the attention of the agriculturist is systematically directed to this point. The rye-grasses, fescues, and meadow-grasses, in particular, exhibited, in nearly every species, wide variations in the yield and habit of growth; and it is by successive selections of the best of these variations, and carefully noticing any cultural peculiarities that may have influenced their production, with a view to future adaptation, that improved forms will be fixed and perpetuated.

ART. XVIII.—*On the occurrence of* OROBANCHE; *a genus new to the Flora of New Zealand.* By T. KIRK.

[*Read before the Auckland Institute, September* 20, 1869.]

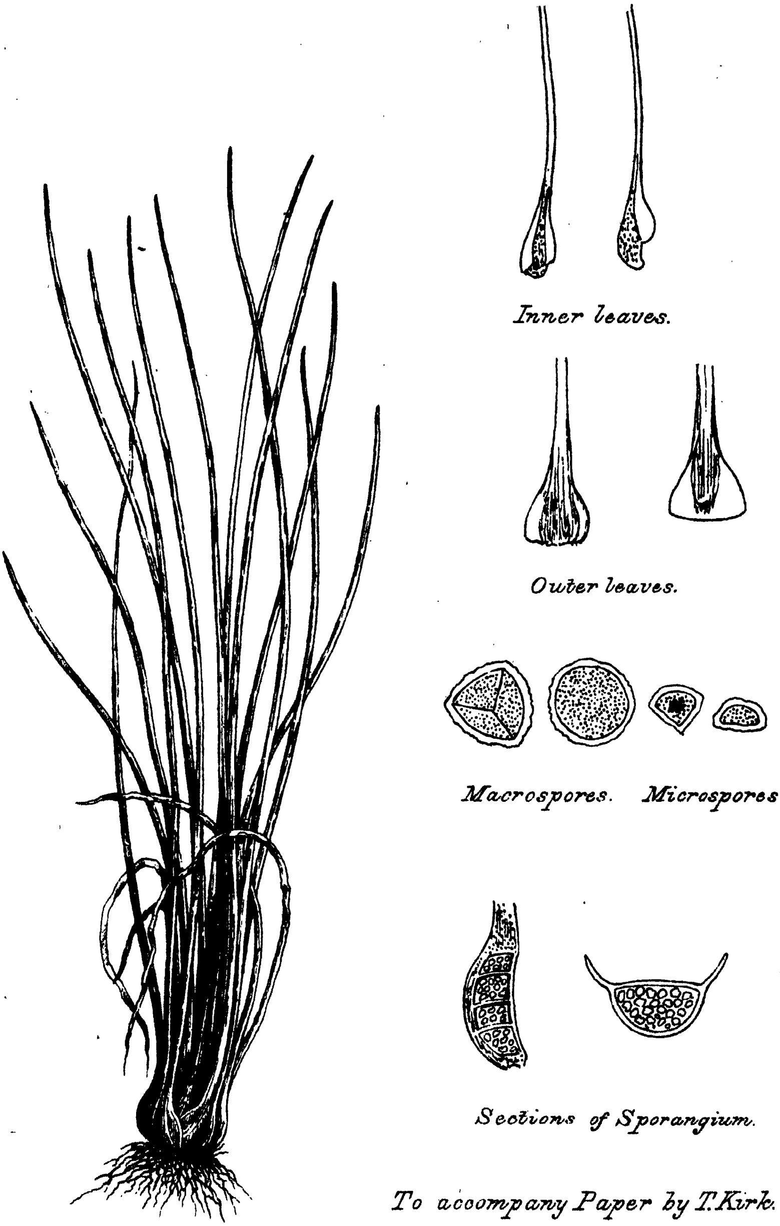
MR. ROBERT MAIR, of Whangarei, has favoured me with a specimen of an Orobanche, discovered by him, and from the interest attending the first discovery of a Broom rape in this colony, I venture to make a few remarks upon the specimen so kindly sent, chiefly with the view of directing the attention of other botanists to the genus.

The specimen is unhappily in a bad state of preservation, having suffered considerably from the attacks of insects, so that it would not be safe to attempt a diagnosis until better material can be procured. From the solitary bract, and sepals narrowed into subulate points, it evidently belongs to the group of which the European *Orobanche minor*, which is commonly parasitic on the roots of clover, may be taken as the type, its nearest ally appears to be the *O. Picridis* (F. W. Schultz), from which it differs (so far as can be judged from the condition of the specimen), in more robust habit, more numerous and closely aggregated flowers, wider bracts, which become much elongated after flowering, in the broader sepals, which are shorter than the tube of the corolla which is more erect, and less ventricose at the base, with narrower tips.

Mr. Mair informs me, "that the plant grows on a sharp ridge, which has never been broken up, and is covered with *Pteris esculenta*, and a few scattered plants of hawk-weed." It is probably parasitic on the roots of the hawk-weed.

In the southern hemisphere, this genus is found at the Cape of Good Hope. A solitary species, *O. cernua* (Loeff.), which is also a Mediterranean plant, is found in Australia, where it is chiefly parasitic on the roots of *Senecio lautus.*

It might be worth while to search for other members of this genus at the roots of our various Araliads, especially of *Panax Colensoi*, and *P. Lessonii*, in hilly districts.



To accompany Paper by T. Kirk.

Isoëtes Kirkii. Braun.
nat. size.

T. Kirk del. J. Buchanan lith.

Printed at the Gen. Gov. Lith. Press by J. Earle.

Art. XIX.—*On the discovery of* Isoëtes, *and other genera of* Rhizocarpæ, *new to the Flora of New Zealand.* By T. Kirk.

(With Illustrations.)

[*Read before the Auckland Institute, October* 18, 1869.]

During the past autumn I had the pleasure of making a short tour in the Waikato, in company with my friend Captain Hutton, specially with the object of searching for Rhizocarpæ, and other obscure aquatic plants. Although our explorations were abruptly stopped by heavy and continued rain, a portion of the results is of sufficient importance to warrant its being placed on record, even in a necessarily imperfect condition, in order to draw the attention of colonial botanists to genera not previously observed in New Zealand, but which will, in all probability, be ultimately found in every province.

Great attention has been paid to the Rhizocarpæ during the last twelve years, especially by Dr. Alexander Braun, of Berlin, and M. Gay, of Paris. At the commencement of that period only one species of Isoëtes was recognized, *I. fluitans*, L.; although it is not unlikely that the plant now known as *I. echinospora*, Dur., may have been the *I. fluitans*, var. *gracilis*, of authors, the differences at that time observed being confined to habit of growth, texture, etc. It is only within the last eight or nine years that the value of the macrospores, as affording specific characters, has been fully demonstrated. More than twenty species are known, of which five are Australasian.

Our Waikato Quillwort proves to be a new species, *Isoëtes Kirkii*, Braun, and is closely allied to the Tasmanian *I. humilior*, F. Muell. The leaves (fronds), are from 2–4 inches in length, rounded and very slender, in strong plants spreading; sporangium 4-celled; macrospores sexangular, with slightly-raised margins, finely punctate; microspores obscurely triangular, minutely punctate. The macrospores appear to vegetate, in many instances, before leaving the capsule, thus forming dense masses of slender pale-green leaves amongst the decaying leaves of older growth.

Other species may be expected to occur in our central and alpine lakes.

Pilularia, sp. Specimens with short solitary leaves, and small capsules, were discovered, but too far advanced to admit of identification.

? *Marsilea*, sp. A solitary specimen, in imperfect fruit, apparently resembling *Marsilea pubescens*, was collected, growing with another obscure plant, which may possibly prove to be referable to the Australian genus Microcarpæa, belonging to the Scrophulariads.

In addition to the above, an undescribed pondweed, allied to the European *Potamogeton zosteræfolius*, Schum., was collected, also *Scirpus fluitans*, L.

Isolepis fluitans, R. Br., (*Eleogiton fluitans*, Link), was discovered for the first time in the colony, and at least three species of Chara, not before recorded.

Of scarcely less interest was the occurrence of *Zannichellia palustris*, L., *Ruppia maritima*, L., *Potamogeton pectinatus*, L., and other plants, not previously known to occur in the Province of Auckland, thus exhibiting a marked extension of their northern and western range.

Art. XX.—*On* Epacris purpurascens, Br., *in New Zealand; with remarks on* Epacris pauciflora, A. Rich. By T. Kirk.

[*Read before the Auckland Institute, October* 18, 1869.]

This attractive plant is stated, in the supplementary portion of the "Flora Novæ Zelandiæ," to have been seen by the late Dr. Sinclair and Colonel Bolton, at Papakura, where I believe it was originally discovered by Mr.

Runciman, about sixteen years ago. It is singular that until last year the precise knowledge of the locality was lost to botanists; neither has the plant been discovered elsewhere in the colony.

Dr. Hooker entertained doubts as to its being indigenous, founded chiefly on its supposed extreme rarity here, compared with its abundance in some parts of Australia, where it is a common plant. *Leucopogon Richei*, Br., affords a similar instance, of a common Australian plant being confined to a small area in these islands. Our plant, however, must be considered as local, rather than rare, since it is found in abundance over several miles of low Tea-tree ground, near Papakura, usually occurring in large isolated patches; sometimes, when sheltered by a large Tea-tree, it attains a stature of nine feet, and is much branched, but more commonly it is from two to four feet high, with long straight shoots, abundantly clothed with attractive rose-coloured, or white flowers.

It is readily distinguished from the other species of Epacris, found in New Zealand, by its constantly recurved, pungent, coriaceous leaves, with long subulate points, the large size of its flowers, and the linear-lanceolate sepals. Small sparsely-branched specimens of *Epacris pauciflora*, with pungent leaves, have been erroneously referred to this species, by New Zealand botanists, and it has been said that *E. purpurascens*, *E. pauciflora*, and *E. Sinclairii*, are but forms of the same plant. The differences between *E. purpurascens* and *E. pauciflora*, are, however, far too wide to admit of their being united (if New Zealand forms *alone* are to be considered, at least); although it will be difficult to maintain *E. Sinclairii* as a species apart from *E. pauciflora*. *E. pauciflora* occurs on open Tea-tree land, and occasionally amongst other shrubs, up to 2000 feet of altitude, at various places between the North Cape and Nelson, but can hardly be considered a common plant. Flowering specimens may be seen a few inches in height, although from four to six feet is a common height, and the plant sometimes forms a large, much-branched, twiggy shrub, thirteen feet high. In the young state, the leaves are sometimes very broad, highly developed, pungent, and more or less recurved, but these characteristics disappear as the plant grows larger. A striking variety found near the North Cape, is sparingly, or not at all branched, with the leaves approaching those of *E. purpurascens*, but always green, never brown; it produces flowers freely, near the tips of the long straight branches; but the flowers are strictly those of the typical form, and the plant becomes gradually branched and twiggy with age, at the same time developing leaves of the ordinary type.

ART. XXI.—*On the Structure and Colour of the Fibre of* PHORMIUM TENAX. By T. NOTTIDGE.

[*Read before the Philosophical Institute of Canterbury, September* 1, 1869.]

As the preparation of the fibre of New Zealand Flax has now become one of the staple industries of this province, I thought that the following account of certain observations and experiments that I have made on the structure of the leaf, and colour of the fibre, of *Phormium tenax*, might not prove uninteresting to the members of the Institute.

As is well known to all botanists, the fibre of the *Phormium tenax* is the woody tissue or pleurenchyma of the leaf. This woody tissue consists of cells very much elongated, and tapering at each end, arranged side by side in bundles, the ends of the proximate cells overlapping.

When the carefully-cleaned fibre is teased out with a needle, and examined under a microscope by reflected light, with a power of 120 linear, it appears

to be white and transparent, like filaments of spun glass, and where it lies in bundles it has a lustre like satin.

When mounted in "Deane's gelatine," and examined by transmitted light with a power of 225 linear, the ultimate fibres appear to be cylindrical tubes of considerable length (probably one and a half to two inches, but I have not succeeded in tracing any one cell through its whole length), the margins extremely smooth and regular, the finest of the fibres quite as fine as the silk of the *Bombyx Mori*, or mulberry silkworm. The cells taper gradually to each end, and are slightly rounded at the point. A central canal of considerable size is plainly visible. I observed no transverse or longitudinal markings on the fibre. The central canal appeared to be filled with air only, when I examined the fibre in August, but this may not be the case at all seasons of the year.

Transverse sections of the upper part of the leaf, mounted in "Deane's gelatine," and examined by transmitted light with a power of 225 linear, show that the fibres are not round, but roughly hexagonal, with slightly-rounded angles packed closely together in bundles, but so that small interspaces are left at the rounded angles. The central canal is marked by a well-defined spot on each ultimate fibre; and around this spot are slight indications of concentric lines, showing how the cell has been built up by successive deposits of cellulose.

The ultimate fibres vary considerably in diameter, those near the green or upper-surface of the leaf being much finer than those near the dull under-surface of the leaf.

When the ultimate fibres are broken, they break transversely, and the fracture has a ragged edge. I could not discover any tendency to tear longitudinally into finer filaments.

The bundles of fibre are in the form of flattened bands, arranged with tolerable regularity, parallel to each other, lengthwise in the leaf, one edge of the band being close to the green or upper-surface of the leaf, the other edge close to the dull or under-surface. Some of the bands appear to be incomplete, and extend only to a short distance from the surfaces of the leaf.

In the centre of each complete bundle of fibres is a brown bundle of spiral or vascular tissue, the central canals in this tissue are larger than the central canals in the fibre. This spiral tissue appears to break up very easily and to separate readily from the woody tissue or fibre.

The bundles of fibre are imbedded in the cellular tissue, known as the parenchyma, or more accurately as the merenchyma, of the leaf, and are immediately surrounded by a layer of cylindrical cells very similar to the cells just beneath the cuticle of the leaf.

The cells of the cellular tissue are, for the most part, filled with the greenish fluid juices of the plant: the grains of chlorophyll—the waxy, green colouring matter of the leaf—being very conspicuous in the cells near the upper surface.

In the lower or butt ends of the leaf, the ultimate fibres are much coarser, the bundles are cylindrical or oval, there is a great thickness of cellular tissue in which the bundles of fibre are imbedded, and the cells surrounding each bundle are filled with some reddish colouring matter, which, in some cases, seems to pervade the whole cellular tissue.

The fibre appears to be quite white and colourless in every part of the leaf, until the cells in its neighbourhood are ruptured.

From the above microscopic examination of the leaf and fibre, I have come to the conclusion that an erroneous opinion is prevalent on the following points, which are important:—

1. There is no woody matter to be separated from the fibre; the spiral

tissue cannot, I think, be considered as woody matter; and from direct examination of the so-called woody matter, on imperfectly cleaned fibre, I have found it to consist of cellular tissue, and portions of the cuticle or skin of the leaf, stiffened and glued to the fibre by the dried sticky juices of the plant.

2. The fibre cannot be indefinitely divided, the cells of the pleurenchyma or woody tissue showing no tendency to tear longitudinally into filaments.

3. The ultimate fibres are shorter than is commonly supposed—probably not more than two inches in length, but on this point I am unable at present to speak definitely.

I have observed that in most of the returns of the sale of New Zealand Flax in England, the discoloration of the fibre is alluded to as an objection, and cause of a diminution in price.

From the above microscopic examination of the fibre, and certain other experiments to which I shall allude, I think I have discovered the chief cause of the discoloration of the fibre, as now prepared, and also a means by which that discoloration may be, to a great extent, avoided.

I have formed this opinion from the following considerations.

The fibre, as it exists in the uninjured leaf, is white, and this is the case, even in the thick butt ends of the leaves. Any person may satisfy himself on this point by carefully dissecting out a bundle of fibre, with as little injury as possible to the surrounding cellular tissue.

The fibre consists of elongated tubular cells containing air, or perhaps a colourless liquid.

In each bundle of fibre, very minute canals are formed by the interspaces between the separate fibres.

The bundles of fibre are imbedded in, and surrounded by, the cellular tissue of the leaf.

The cells of the cellular tissue are for the most part filled with sticky juices of the plant, containing chlorophyll, albumen, fibrin, pectine, starch, gluten, sugar, all that is popularly called gum, and in the butt ends of the leaf, the cells immediately surrounding the fibres, contain a red fluid (probably altered chlorophyll).

In the process of manufacture, the leaf is beaten or bruised, the cellular tissue is completely broken up, the fluid contents of the cells are set free, and, by the same cause, openings would be forced in the tubular cells of the fibre, whether those cells contained fluid or air, and if they contained fluid some of that fluid would be pressed out.

The result is obvious, the fluid juices would be drawn into the tubular fibres and into the minute canals between the ultimate fibres, by capillary attraction, and the tubes being so minute, the capillary attraction would act very rapidly, and with great force.

The remedy that I would suggest is simple. It is to dilute the juices of the plant with water the very instant they are set free, so that the tubes may absorb a mixture of juice and water, the more dilute the better, instead of the pure juice.

The following facts tend to show that the above views are to a great extent correct.

The fibre as it leaves the beating or stripping machines is green in colour, and this green colour cannot be removed by mere washing.

When the moist fibre, washed so as no longer to tinge water green, is passed between powerful rollers, a large quantity of green fluid is expressed.

The colour is improved by passing the moist fibre between rollers, or through a beating machine, under a stream of water, and the sooner the water is applied after the fibre has passed through the stripping machine the greater

is the improvement in the colour. For this last statement I am indebted to the manager of the Selwyn Flax Company, who has been making experiments on the washing of the fibre.

If the beating of the green leaf is effected under water, the resulting fibre is quite white.

If the green leaf is half dried, so that the juices may not flow freely in very minute tubes, and the fibre is then prepared by beating and subsequent washing, the fibre is much whiter than if prepared from the fresh-cut leaf in the ordinary manner, but the difficulty of separating the fibre from the cellular tissue is greatly increased.

Such are my views on the above subject, and the chief reasons which have led me to adopt them. It will be seen that the question goes far beyond the mere discoloration of the fibre. The green colour of the juices, if absorbed as I have suggested, might, no doubt, be removed by bleaching, so as to stain the fibre a light brown colour only; but the juices could not be washed out, and when dried up would leave a residuum by which the interior of each tubular cell would be coated, and thereby to some extent rendered harsh and brittle, the ultimate fibres of each bundle would be glued together so as greatly to increase the difficulty of adapting the fibre for textile purposes, and this residuum, when exposed to air and moisture, would probably be subject to chemical changes which might have a most injurious effect on the fibre.

I have alluded to the spiral vessels found in the centre of each bundle of fibre, in the leaf of the *Phormium tenax*. This spiral tissue is found in all phœnogamous plants and ferns, and from the careful manner in which it is generally protected, I suspect that it serves some very important purpose in the economy of the plant, but physiologists do not agree as to its precise function. It is found most abundantly on the inner bark, in the veins of the leaves, and immediately round the pith in the centre of the stem of exogenous trees. It is very abundant in the *Musa textilis*, a species of banana, from which the Manilla fibre is obtained, and it is from the uncoiled spiral threads of this vascular tissue that textile fabrics are manufactured, not from the true fibre known as Manilla, and used for rope. I mention this, because from ignorance of this fact it has been suggested that the process, by which fibre from the *Musa textilis* is prepared for fine textile fabrics, might be applicable to the fibre of the *Phormium tenax*.

My principal object in writing this paper was to give publicity to my views. Even if my theory is shown to be erroneous, I hope that it may lead to further experiments, and provoke discussions tending to the improvement of the manufacture of New Zealand Flax.

Art. XXII.—*On the Structure of the Leaf of* Phormium Tenax. By Captain F. W. Hutton, F.G.S.

(With Illustrations.)

(Read before the Auckland Institute, October 18, 1869.)

In the present paper an attempt has been made to describe the structure of the leaf of our native Flax, so as to form a basis for the examination and comparison of the manufactured fibre, as dressed by different machines, and prepared by different processes, on which subject I hope we shall receive communications from many of our members. I have also added some observations on the gum secreted by the leaf, and which is generally looked upon as the *bête noire* of the manufacturer, but which I believe not to be so black as it is painted. While it was in progress, I saw in the newspapers a short abstract

of a paper on the same subject, read by Mr. Nottidge, to the Philosophical Institute of Canterbury. Not having as yet had the pleasure of reading this paper, I am not able to refer further to it; but judging from the very short abstract that appeared in the papers, we seem to be pretty well agreed upon all points, except as to the existence of small canals in the fibro-vascular bundles, formed by the inter-spaces between the ultimate fibres, which, I venture to suggest, must have been caused by the knife tearing apart the bundles of fibres, when making transverse sections.

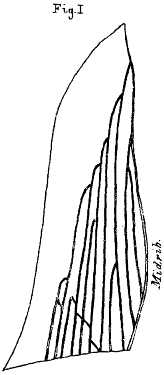
Development of leaf.—The young leaf of the Flax plant (*Phormium tenax*), when about a quarter of an inch in length, is composed of loose parenchymatous tissue, covered both on the inner and outer surfaces, near the centre, by an epidermis of elongated rectangular cells, the edges of the leaf being crenulated by the jutting-out of the young growing cells. Imbedded in this cellular tissue lie about twenty-three vascular bundles, eleven on each side of the midrib. These, in this young state, are composed entirely of spiral-vessels, which contain a single spiral fibre, easily unrolled with a needle. These bundles are 0·0013 inch broad, and about 0·004 inch apart from one another. (Fig. I.) They lie longitudinally in the leaf, towards the central part of it, the outer growing edge being composed only of cellular tissue. The upper end of each bundle runs into that lying next to it towards the centre, and they thus get shorter and shorter as they recede from the midrib. When the leaf gets about an inch long, the vascular bundles are still seen to branch and anastomose with one another (Fig. II.); but this soon ceases, and at all later stages they are very nearly parallel, converging slightly towards the point of the leaf. A layer of thin elongated tubes now makes its appearance, surrounding the bundles of spiral vessels. This is the first state of the fibres from which the plant has got its celebrity; but as yet they are exceedingly tender, and break with the slightest touch. When, however, the leaf has attained a length of four inches, the fibres in the upper part of it have acquired considerable strength, while those at the base are still quite weak. When the leaf is about nine inches long, it commences to exude gum, and appears then to be fully formed.

Description of full-grown leaf.—When fully grown the leaf attains a length of from three to ten feet, according to soil and variety. The colour varies from light yellow-green to deep blue-green, with yellow or red margins and midribs, while the lower part of the leaf is usually pink. In shape the leaf is linear-lanceolate, and keeled, with an acute point. At a point rather less than half way down from the tip, the two superior or inner surfaces of the two halves of the blade begin to coalesce at the midrib, and this coalescence gradually increases until one-half of the leaf is joined together. The coalescence then gradually decreases, until it occupies only about a fourth of the breadth of the half blade, which breadth it keeps to the bottom of the leaf, the two half blades being closely appressed as far as the base, where the two marginal edges closely overlap one another, and form a sheath through which the younger leaves grow. It is only the inner surfaces of the lower portion of the leaf, below the place where the coalescence of the two half blades begins to decrease, that exude gum.

For the sake of convenience, I shall, in this paper, call the upper part of the leaf, the blade; that portion where the coalescence of the two half blades reaches its maximum, and which is about half-way between the two ends of the leaf, the butt; and the lower portion, the base of the leaf.

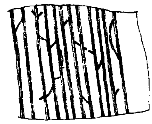
The full-grown leaf is composed of parenchymatous tissue, in which fibro-vascular bundles lie imbedded, and remain isolated from one another as fibrous cords, some of which run from one end of the leaf to the other. This cellular tissue is covered, on both surfaces of the leaf, by an epidermis composed of

Fig. I



Half of young leaf × 16.

Fig. II.

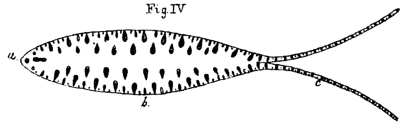


Portion of leaf when one inch in length × 25.

Fig. III.

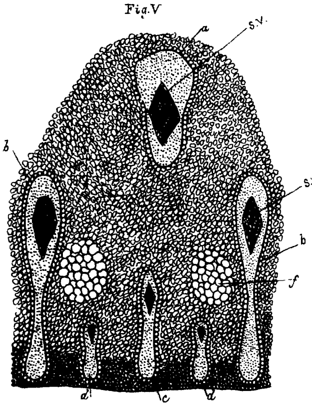
End of Fibre × 300

Fig. IV



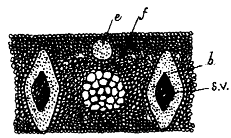
Section through butt. × 3.

Fig. V



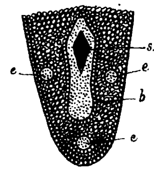
Portion at b. Fig. IV × 34.

Fig. VI.



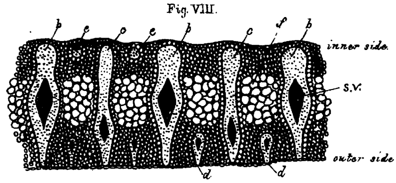
Portion at c Fig. IV × 34.

Fig. VII.



Portion at a. Fig. IV × 34.

Fig. VIII.

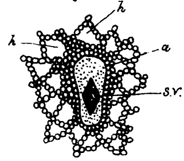


Section of leaf × 34.

Fig. IX.

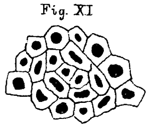
Margin of leaf. × 34.

Fig. X.



Section of vascular bundle and cellular tissue with passages at base of leaf × 34.

Fig. XI



Section of part of a bundle of fibres. × 450.

To accompany Paper by F W Hutton on the structure of the Flax leaf.

F.W. Hutton del. J.B. lith.

Printed at the Gen. Gov. Lith. Press

elongated, rectangular cells, of considerable consistence, but without chlorophyll, or other colouring matter.

No stomata or other openings are found on either surface, and the gum appears to be exuded by exosmosis.

The fibro-vascular bundles, which form what are commonly called the fibres of the plant, are composed of elongated tubular liber-cells, enclosing a centre of spiral vessels, and vary much in shape in different parts of the leaf. They are surrounded by a layer of elongated cells, that at once turn blue with iodine, and are probably cambium cells. The bundles are thickest at the base, and taper gradually to the point of the leaf.

The spiral vessels are about 0·001 inch in diameter, and contain a single, rarely a double, spiral fibre, which can be unrolled with a needle. They are filled with air, and have no strength, but are readily broken across.

The liber-cells, on the contrary, have great strength, and form the true fibre of the leaf. They are very long, probably an inch or more, while their thickness never exceeds 0·0006 inch, and is sometimes only 0·0003 inch.* They taper each way to a more or less blunt point (Fig. III.), each cell being distinct from the rest, and not joined together end-ways. Notwithstanding their strength they are of very delicate structure, colourless, translucent, and almost devoid of secondary deposits, the cell-wall being from 0·0001 inch, to 0·0002 inch, thick. They are hollow, and filled only with air, but are highly hygroscopic, imbibing water quickly, and during the operation twisting about in all directions. The fibres, although round when separated, are not so when collected into bundles (Fig. XI.), being then compressed into ovals, polygons, etc., so as to fill up the whole space, and leave no interstices. They have the same thickness in all parts of the leaf.

At the base of the leaf the vascular bundles are scattered through the cellular tissue, in about four irregular rows. They are arranged in ovals of two sizes; the largest, whose major axis is about 0·02 inch, and minor axis 0·014 inch, enclose, in their centres, a rhomboidal cluster of spiral vessels (Fig. X. s. v.); while the smaller, whose major axis is 0·015 inch, and minor axis 0·007 inch, contain none. Near the outer surface of the leaf four other irregular rows of fibre bundles, without spiral vessels, are found, whose section is lanceolate, thus making eight rows altogether in the base of the leaf. The fibres here are generally much weaker than in any other part, and can be easily torn across with a needle.

Near the outside of the leaf the cellular tissue, in which these bundles are imbedded, is lax and translucent, but towards the interior it is open and spongy, the cells being arranged in single rows, enclosing irregular inter-cellular spaces (Fig. X.h.), which are of a tubular form, the tubes running parallel with the vascular bundles. These inter-cellular passages begin to be developed when the leaf is about four inches long, and they are found only in those parts where gum is exuded. At present I have always found them empty, but it is possible that they may be gum-canals, or the glands or ducts by which gum is secreted.

In the thick part of the butt of the leaf, the internal rows of bundles are reduced to one, the others having died out. (Fig. IV.) They are here club-shaped, with a constriction in the middle (Fig. V.a.), and enclose a rhomboidal bundle of spiral-vessels (Fig. V. s.v.). Besides these there is also a marginal row of bundles, the largest of which (Fig. V.b.) alternate with the bundles of the interior row. They are of an elongated clavate form, constricted in the

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* What are called the cotton-like, or hair-like, filaments of the flax, are far from being the ultimate fibres, but are single bundles containing perhaps 100 or more liber-cells; the ultimate fibres are all but invisible to the unassisted eye.

middle, and with a rhomboidal bundle of spiral-vessels (Fig. V. s.v.) in the thick part of the club. Between these occur three smaller bundles, of an oval form, also constricted in the middle. The central one of these, which is situated just opposite to the interior bundle (Fig. V.c.), is rather more than half the length of the largest, and encloses near its inner end a rhomboidal bundle of spiral-vessels. The other two are of the same form as the central one, but not much more than half its length (Fig. V.d.), and the bundles of spiral-vessels, which are also near the inner end, are in section like the sector of a circle, or a boy's kite. The cellular tissue which encloses these bundles is rather lax, and of a light-green colour, becoming close, and densely filled with chlorophyll, towards the outer side. All traces of the inter-cellular passages have disappeared, but in their place two cylindrical bundles of large, loose, translucent cells (Fig. V.f.) appear near the end of each of the smallest marginal bundles, and these continue to the point of the leaf. The cells that surround the interior bundles, and the rounded interior ends of the largest marginal bundles, are filled with a red fluid, as are also those of the midrib and margins of the leaf.

The vascular bundles in the free part of the leaf, at the butt, are rhomboidal in section (Fig. VI.b.), reaching the epidermis on the outer or inferior surface, but separated by several rows of cells from the inner or superior epidermis; they enclose bundles of spiral-vessels (Fig. VI. s.v.) that are also rhomboidal in section. Midway between these, and near the superior surface, there sometimes occurs another small cylindrical bundle (Fig. VI.e.) of liber cells, without any spiral-vessels, but more often this is absent. Between each of the vascular bundles there is also a cylindrical bundle of large loose cells (Fig. VI.f.), similar to those in the thick part of the butt. The midrib (Fig. VII.) is formed by an elongated bundle of fibres, enclosing a rhomboidal bundle of spiral-vessels near its inner end, and it is surrounded by three circular bundles (Fig. VII.e.) of fibres alone.

Higher up in the blade, as the free parts of the leaf get larger, the interior bundles of the butt die out, and the medial-sized marginal bundles elongate, until they, as well as the larger ones, reach almost across the leaf (Fig. VIII.) from the outer to the inner surface, the smaller ones (d.) retaining their relative size. All have, however, now altered in shape; the larger ones are still clavate, but are swollen, instead of constricted, in the middle; and the swollen parts contain their bundles of spiral-vessels, which neither in shape nor in relative position have changed with the liber-cells. The smaller, or intermediate bundles (Fig. VIII.d.) have become more clavate; but their spiral-vessels have still retained their shape of the sector of a circle. Occasionally on the inner side of the leaf small round bundles (Fig. VIII.e.), composed altogether of fibre, are found, alternating with the bundles that cross the leaf.

The average thickness of these bundles on the superior or inner surface of the leaf is 0·005 inch, and on the inferior or outer surface, 0·0027 inch, and their distance from one another is 0·018 inch, or fifty-five bundles to the inch. There are, therefore, about two hundred and fifty bundles of fibre in the whole breadth of the leaf, not including the intermediate bundles, which would give about as many more in the lower part of the blade near the butt; but towards the point of the leaf these intermediate bundles die out, leaving only the large ones, that go the whole way across. These also get finer and closer together the nearer they get to the point, so that there are almost as many of them close to the tip of the leaf, as there are near the butt. On the inferior or outer surface, the bundles of fibres reach to the epidermis, but on the superior or inner surface, several rows of cells intervene. Each bundle of fibres is separated from the next to it, in the interior of the leaf, by a mass of lax

translucent cells (Fig. VIII. f.) similar to those found in the butt of the leaf. The rest of the cellular tissue is densely filled with chlorophyll.

The Maoris, in cleaning the fibre, cut through the outer or inferior surface of the leaf, as far as the lax tissue in the centre, then tearing out that part which contains one half of each of the bundles that cross the leaves, and the intermediate bundles, with the small quantity of cellular tissue between them, they throw away the inner or superior surface, together with the other half of the large bundles of fibres. The cellular tissue, already broken up by tearing it away from the rest of the leaf, is easily got rid of, and thus the fibre is both finer and cleaner than that prepared by the machines. Of course the system is very wasteful, and it would never do for us to follow it, but I would suggest that it might be very advantageous to split the leaf longitudinally, so as to divide the inner and outer surfaces before putting it through the machine, as by this means the bundles of fibres would be split into two, and a finer, as well as a cleaner, article obtained.

Gum.—The gum of the flax plant, when first exuded, is a thickish, sticky, colourless fluid, that runs down the leaf when it is cut. It gradually hardens into a semi-solid, jelly-like, viscid substance, and ultimately into a thin tough pellicle, which can be easily peeled off the leaf, and which generally retains the markings of the cell-walls of the superior epidermis. When pure it is colourless, or pale yellow. It shews no microscopical structure, but generally contains small pieces of vegetable tissue, etc., and sometimes several animals, which live in it. On exposure to the sun, it shrinks greatly, and after a few days hardens into a tough solid substance, not easily broken.

In its first, or fluid state, in which alone it exists in the interior of the plant, it readily mixes with water. Both in its usual semi-solid state, and after hardening in the sun, it softens and intumesces in cold water, but only partially dissolves. In boiling water, it dissolves readily, when in the semi-solid state, but with difficulty after having been dried. Alcohol fails to dissolve it, but turns it white. It is unaffected by the caustic alkalies, but dissolves easily in acids. Iodine colours a solution of it yellow, without any trace of blue.

Neither alcohol nor neutral acetate of lead produce any effect upon a solution in water; but it is precipitated, of a yellowish-white colour, by tribasic acetate of lead, by protochloride of tin, and by nitrate of mercury.

These reactions show that it differs from all the gums, by not being precipitated by alcohol, and further, from the gum-arabic group by its insolubility in cold water; from the cherry-tree gum group, by its being precipitated by nitrate of mercury; and from the gum-tragacanth group by its insolubility in caustic alkali, while it is allied to this latter by its intumescing and partly dissolving in water. On the other hand, on all these points, except the solubility in cold water, it agrees with carrageen and linseed mucilage; and the latter, after having been dried, intumesces in water, and only partially re-dissolves. From all the mucilages, however, our flax gum differs in its behaviour with neutral acetate of lead, which proves that it contains little or no pectin, and in this respect it is like the true gums. It appears, therefore, that flax gum is intermediate between the gum-tragacanth, or Barsorin group of true gums, and the mucilages, and ought, strictly speaking, to be called a gum mucilage.

We are thus led to the following conclusions:—

1. That the object to be aimed at, in manufacturing the fibre, is the separation of the fibro-vascular bundles from the cellular tissue and epidermis of the leaf, and not, by any means, the breaking up of the bundles into their ultimate fibres, which would entirely destroy their strength.

2. That the bundles of fibres in the leaf are of different sizes.

3. That no woody fibre exists in the leaf, but the liber-cells have thin walls of delicate construction, which probably accounts for the quick deterioration of the fibre by over-bleaching, or by the use of chemicals.

4. That the gum appears to offer no peculiar obstacle to the manufacturer, provided the leaves are above the butt, for in the state in which it alone exists in the interior of the plant it readily mixes with cold water.

ART. XXIII.—*On the* NEW ZEALAND FLAX, (Phormium tenax). By Major HEAPHY, V.C.

[*Read before the Auckland Institute, October* 18, 1869.]

THIS plant grows in nearly every part of New Zealand, Chatham Islands, and Norfolk Island. It is said to exist on the Lachlan plains in New South Wales. In New Zealand it occupies a zone from the beach to an elevation of 4000 feet.

It has been generally supposed that there were three varieties, viz., the *P. tenax*, *P. Colensoi*, and another kind, discovered by Dr. Hector on the south-west coast of the Middle Island.

The *P. tenax* is described as having a leaf from 3 to 6 feet in length, and a flower-stalk from 6 to 16 feet in length, with a yellow and red flower, and inhabiting the Bay of Islands and northern districts.

The *P. Colensoi* is described as having a leaf 2 to 3 feet in length, and a flower-stalk from 3 to 6 feet in length, with a pale flower, and being found as far south as lat. 46° 30′.

Sir William Hooker doubts if these are distinct varieties, as they do not appear to be more dissimilar than Fuchsias and other flowers will become by different modes of cultivation.

The largest flax grows on the immediate margins of rivers, such as the Waikato, Wairoa, and Thames, where the rich slime brought down in the freshets affords the nutriment fitting for the most luxuriant growth of the plant. The plant growing in swamps is of inferior size to this.

The quality of the fibre which the leaf contains, varies much with the character of the soil, the hilly and dry ground producing a kind very much superior to that of the river-edge and swamp,—a rule modified, however, by the quality of the soil.

According to the natives, the various kinds on the east coast of the North Island are:—

1st. The Witau, yielding a poor fibre.

2nd. The Motu-o-rui and Awanga, a variegated kind, the fibre unserviceable for manufacture.

3rd. The Wara rika, and Manga eka, yielding a fibre of ordinary character.

4th. The Oue or Tapoto, yielding a beautiful glossy or silky fibre, but of so brittle a character as to require a mode of preparation in which a knife or scraping implement may not be used. The natives soak the leaf to soften the epidermis, which they strip off by shaking and drawing it through the hand, whence it obtains the name of "Tihore," by which the plant is generally, but improperly, known.

The Oue should be grown on a rich, deep soil, not swampy. The best fibre is very much prized, and is used for the Kaitaka, or bordered mat.

Some of this flax was manufactured in France into fabrics, that resembled fine jean and silk in delicacy of gloss.

The Oue is frequently planted by the natives in borders to divide small cultivations near a village, and where it is convenient for occasional use in mat-making. In this case, it constitutes quite a property. It may be seen in the cultivations at Coromandel harbour, Kawhia, and the Waikato.

The Oue is rarely more than 5 feet high. The leaves are very glossy, and rather red at the edges, causing the plant to assume, at a distance, rather an orange-green colour, as against the bluish-green of the other kinds.

5th. The Rongotainui. This flax grows most extensively on the East Coast, and at the Bay of Plenty; it is, of all, the most prized for the manufacture of fishing lines and cordage.

The Rongotainui is probably the best for commercial purposes generally; it is rather scarce in its wild state, but is carefully grown about the native settlements. The leaf of this kind of flax may be scraped or beaten without injury to the fibre which it contains. The natives cut across the epidermis on the under side of the leaf, previous to drawing it over the edge of a shell or knife.

On the West Coast, and at Taranaki, the flax called Hati rau kawa is used by the natives for the finest mats; it is probably the same as the Oue. The following are also known to the West Coast natives, viz:—

1st. The Pare kore tawa, Huhiroa, [probably "Oue roa"] Rataroa, and Tihore yielding the best fibre.

2nd. The Ngaro, Tara riki, Wara riki and Pato. The Ngutunui, Ngutu parura, and Tai one contain a stiff fibre.

The Raumoa and Manunui are good kinds for cordage.

Mr. Hursthouse states that, at Taranaki, the Takaiapu, Ate weka, and Korako are of a first-rate quality. There are also kinds called the Tepuna and Tutai wiki.

It is probable that many of the above-mentioned are the same, under different names; there appears to be no marked generic difference in any, save that from the South-west Coast; but difference of climate, locality, and soil will no doubt alter the relative quality and quantity of the fibre, and the appearance of the plant.

The Oue should be grown in rich, deep soil, properly drained. The hill flax as a rule yields the largest proportion of fibre, to weight of leaf, but the leaf is generally short.

The leaves may be cut twice a year. After steeping, the natives make the Oue leaves up into small bundles, and hang them on horizontal poles to dry, shaking and rubbing the leaf, from time to time, to get off the fleshy part of the leaf. A chemical process would probably be more suited to the preparation of this kind of flax. It is important to remember that the Oue or Tihore should not be exported for rope-making purposes, nor, if possible, the other kinds for textile fabrics.

The native names for the various parts of the flax plant, are:—Purake or Pakauka for the outside leaves, which are rejected, the Muka, or inner leaves, are collected for use, and the Rito, or unfolded leaf, is carefully left uncut.

The Korari is the name of the flower stalk, often, but wrongly, used as the name of the plant. The edible root is the Aruhe.

The word "Muka" is commonly applied to the dressed fibre; it is the correct name for the inner leaves.

Cleared bush-land is suitable for the cultivation of the flax plant, and even swamp-land is improved by drainage. In the various flax swamps near Nelson, through which roads have been made, it is invariably found that the finest plants grow upon the soil that has been thrown out of the ditch, at the road side.

When cultivated, each plant should have about two square yards of ground. An acre would thus give room for 2420 plants. About 10 lbs. of leaf will be obtained from each plant. A farm of one hundred acres would give 1085 tons of leaf. Allowing one-sixth of this to be convertible into fibre, 180 tons of marketable flax would be the result.

ART. XXIV.—*On the Vegetation of the neighbourhood of Christchurch, including Riccarton, Dry Bush, etc.* By J. F. ARMSTRONG, Government Gardener.

[*Read before the Philosophical Institute of Canterbury, December* 2, 1868.]

Introductory Remarks on the Distribution of Plants in the Province of Canterbury. By JULIUS HAAST, Ph.D., F.R.S.

SINCE the appearance of Dr. J. D. Hooker's excellent "Handbook of the New Zealand Flora," it has always been my wish to see the compilation of the names of all the plants which grow in the neighbourhood of this city, undertaken; because I have often observed, that few persons, even those acquainted with the rudiments of botany, know what plants really grow wild near Christchurch, and when they should look for them. Unfortunately my own occupations have not allowed me time to prepare such lists, I therefore induced our member, Mr. J. F. Armstrong, to devote his leisure time to do so, and there is no person here more competent to perform such an arduous task.

I may be here allowed to state, that for more than four years Mr. Armstrong, and his son Mr. J. B. Armstrong, have assisted me in collecting our indigenous vegetation, for the herbarium of our Museum, and for making exchanges; and both have also given me great help in arranging the botanical collections belonging to the province. In fact, whilst I was collecting and investigating the alpine and sub-alpine Flora of New Zealand, my two botanical assistants did the same work in the neighbourhood of Christchurch, and contributed several complete sets of plants to the Museum, which, however, like the great bulk of our botanical collections, have hitherto been inaccessible to the public, for want of space to exhibit them in.

The vegetation of the province of Canterbury, as formerly constituted, may be divided into five main groups or zones, which again can be formed into many sub-divisions.

The five main zones are:—

1. The *Littoral zone*, in which grow, generally, only plants which are peculiar to the sea-shore, from high-water mark to 25 feet above it.

2. *Lowland zone.* This comprises the lower portion of the Canterbury Plains, of Banks' Peninsula, and of Westland. I propose for this group the name of *Pine zone.* Altitude above sea-level, 25 to 800 feet. On Banks' Peninsula, to 1200 feet.

3. *Mountain zone*, formed by the vegetation, mostly Beech or Fagus, which covers, where still existing, uniformly the sides of the mountains bordering the Canterbury Plains, and the foot of the central ranges, both on the east and west sides. It may appropriately be called the *Beech zone.* Altitude from 800 to 4000 feet. In the interior of the Alps, it rises only to 2500 feet.

4. *Sub-alpine zone*, formed by a great variety of shrubs, and a few stunted trees. It ranges from 2500 to 4500 feet, and includes the lower portion of the interior of the province, and the highest summits of Banks' Peninsula.

I propose to call it the *Dracophyllum zone*, as this genus, belonging to the Ericeæ or Heaths, is always well represented, and most conspicuous in the regions referred to.

5. *Alpine zone*, on the summits of the mountains bordering the Canterbury Plains, and on the sides of the alpine ranges, growing to the line of perpetual snow, from 4000 to 7000 feet.

It consists of herbaceous plants, often growing in dense, carpet-like swards. I venture to call it the *Raoulia zone*, from that genus assuming such conspicuous forms in those regions.

There are, of course, many gradations from the one into the other, as all

depends upon the aspect, orographical features, mean altitude, and many other secondary causes.

Banks' Peninsula has, in many respects, a peculiar botanical character, as some of the zones are here, as it were, blended with each other in a very striking manner. Moreover, several species of plants growing here, are not to be met with elsewhere.

The sand-hills near Christchurch are very good examples of the first, or *Littoral zone*, which consists mostly of creeping succulent plants, fond of saline matter, and of sedges, grasses, and a few small shrubs.

The second or *Pine zone*, is well represented in our neighbourhood by the Riccarton Bush, and still better by the forests on Banks' Peninsula.

It contains, from its low position, the most luxuriant portion of the New Zealand vegetation, high, straight trees, growing closely together, interwoven by numerous lianas, their stems covered with mosses and ferns, and with a dense undergrowth of shrubs and fern-trees.

This second, or *Pine zone*, is very rich in species, whilst the third, or *Beech zone* is remarkably uniform, except on the edges of the forest, or along the water-courses, where shrubs and some smaller trees are mixed with it. But once fairly entered into the Fagus (or Beech) forests, we find very little undergrowth, and the stems of the trees are remarkably clean.

The vegetation of Christchurch and its neighbourhood belongs to the first and second zones, with which Mr. Armstrong will make us further acquainted.

The Vegetation of the neighbourhood of Christchurch. By J. F. ARMSTRONG.

Before entering into the subject of this paper, I may be allowed to make a few personal observations, and to request that you will kindly grant me your indulgence for this my first Essay.

I should never have ventured to bring these notes before the Institute had not our President urged upon me, that the preparation of the lists would be very desirable.

I have, therefore, occupied my leisure hours with drawing up these lists; in doing which, my son, who for several years has almost exclusively occupied himself with botany, has rendered me most effectual help, in naming the mosses, ferns, fungi, etc.

I am well aware that these lists are still incomplete in many respects; but I have no doubt, that, in the course of next year, much more material will be collected, so that in a short time they will contain the names of all the plants found within a radius of ten miles around Christchurch.

As Dr. Haast has kindly written some introductory remarks to my notes, I need not enter into botanical geography, but simply state that the vegetation of the country, of which I shall treat, belongs to the first, or littoral zone; and to the second, or pine zone.

It is my intention to furnish, at some future day, a complete list of the plants in this district, classified according to Hooker's "New Zealand Flora." I shall at present only give lists of the most prominent localities, in which a great variety of vegetable life gladdens the eye of the friend of nature.

Amongst these localities none is more conspicuous than the Riccarton Bush, which, as the following list will show, is remarkably rich in species. In fact we have there a small remnant of the large forest, formerly, without doubt, covering the Canterbury Plains, giving us an insight into the luxuriant forest vegetation, which, in a bygone age, flourished here.

The principal portion of the forest consists of the noble coniferous trees, *Podocarpus Totara*, *P. ferruginea* (Black Pine), *P. spicata*, *P. dacrydioides* (White Pine), *Elæocarpus dentatus* (Hinau), fifty feet high, with pendulous racemes of white flowers. The bark of this tree yields a permanent dye, used by the

Maoris for colouring mats and baskets. *E. Hookerianus*, similar to *dentatus*, but smaller. *Plagianthus betulinus* (Ribbon Wood), wood of which is worthless. *Pittosporum eugenioides*, a small, beautiful tree, with yellow, sweet-scented flowers, bark resinous, wood white, useful for cabinet work. *Carpodetus serratus*, flowers white, profusely produced; wood tough, useful for axe handles. *Panax crassifolium*, the Ivy tree.

SHRUBS, ETC.

Drimys axillaris, a large evergreen shrub, aromatic and pungent, used by the Maoris for various diseases, the "Winter's bark" of New Zealand, Pepper tree of the settlers, wood used for veneers. *Melicytus ramiflorus*, a large shrub, with soft white wood, useful for cabinet work, leaves eaten by cattle. *Pittosporum tenuifolium*, a large evergreen, pyramidal shrub, with purple flowers, wood hard, yellowish, useful for cabinet work. *P. Colensoi*, similar to the last, but larger, wood useless. *Hoheria populnea*, a large shrub, with abundantly-produced white flowers, the bark affords a demulcent drink, and is also used for cordage. *Aristotelia racemosa*, a very handsome shrub, with large racemes of reddish, nodding flowers; wood very light, said to be good for veneers. *Pennantia corymbosa*, a large, very beautiful shrub, covered profusely with very fragrant white flowers. The wood was formerly used by the Maoris for kindling fires, by friction. *Coriaria ruscifolia*, a small shrub, foliage poisonous to cattle, etc.; the seeds are said to produce delirium and death. A beverage, like elderberry wine, is made from the juice. *Urtica ferox*, the Stinging Nettle, stings most violently; the pain lasts three or four days. *Rhipogonum scandens*, Supplejack. The long under-ground stems have been used as sarsaparilla by the settlers; the stems as cordage, by the Maoris. *Phormium tenax*, the fibres of which are very strong; its roots, also, have been used as a substitute for sarsaparilla.

Another interesting locality, in the neighbourhood of this city, and visible from our streets, is the so-called Dry Bush, which, from numerous fires having passed through it, has a scorched appearance. Although there are some large coniferous trees in this small forest, it has more the characteristics of that portion of our bush vegetation which invariably edges our larger forests, of which the Mount Pleasant Bush is a still more characteristic representative.

The only conifers are *Podocarpus Totara*, and *P. ferruginea*. The other principal forest trees are *Alectryon excelsum* (Titoki), a beautiful tree, with large panicles of reddish flowers; the oil of the seeds was formerly used by the Maoris for anointing the person; wood hard and durable. *Sophora tetraptera*, var. *grandiflora*, a beautiful tree, with large pendulous yellow flowers, wood red, valuable for fencing and cabinet work. *Fuchsia excorticata*, wood white, soft, probably worthless.

There are in this small bush about twenty-eight species of shrubs, enumerated in the appended list; some of them are very beautiful, and worthy of cultivation in our gardens; while others may prove useful for their medicinal properties. The most remarkable among these are *Carmichælia australis* and *C. juncea*, with beautiful pea-like flowers. *Discaria Toumatou*, the spines of which were used in tattooing. *Myrtus obcordata*, *Piper excelsum* (Kava Kava), the New Zealand Pepper tree: a beverage, called kava, was formerly made from the roots and leaves by the Maoris; an infusion of the leaves is used to cure toothache. *Clematis*, n. sp., a curious leafless climber, with verticillate, yellow, sweet-scented flowers.*

THE SAND-HILLS.

It is evident from the shifting nature of the ground in the littoral zone,

* See List of Plants of Otago, by J. Buchanan, p. 38, "Trans. N. Z. Inst.," Vol. i.

that no large or continuous vegetation can occur; at the same time, from its diversified appearance, it is peculiarly interesting to the botanist. There we meet with a few shrubs, such as Cassinia, Carmichælia, Discaria, Pimelia Arenaria, with its peculiar baccate fruit; and a considerable variety of herbaceous plants, principally consisting of coarse grasses, Carex, Clematis, Ranunculus, Scleranthus, superior to the *Kew grass* for lawns, verges, etc., Tetragona, Pratia, six species of Orchideæ; and among Ferns, *Pteris aquilina*, *Botrychium virginicum*, the rare British fern *Ophioglossum vulgatum*, and Drosera.

As new plants are discovered every year, we are forced to the conclusion, that the flora of this neighbourhood is imperfectly known.

My best thanks are due to Mrs. Deans for having always given me permission to collect plants and specimens at Riccarton, whenever I required them.

The appended lists contain about 290 species of plants, including 230 flowering plants. As the total number in New Zealand is under 900 sp., we may conclude that the collection is tolerably complete. The number of ferns is 38 sp.; I believe there is no probability of future additions being made to this number. Of mosses, lichens. etc., only 26 sp. have been collected, but in this class there still remains an ample field for future discovery. Although I consider that the greater part of the flowering plants in the district have now been collected, much remains to be done in tracing the distribution of species; for, although the area is small, it contains several assemblages of species.

I find that there are five plants in the district which have not been found elsewhere: they are, *Clematis*, n. sp.; *Carmichælia*, n. sp.; *Anquilaria Novæ Zelandiæ*, n. sp.; *Senecio saxifragoides*, and *Fuchsia Colensoi*.

Riccarton Bush contains—forest trees 13 species, shrubs 27, climbers 10, herbaceous 34, ferns 14, mosses and lichens 20. Total 118.

Dry Bush.—Forest trees 15, shrubs 32, parasites 3, climbers 11, herbs 24, ferns 13, mosses 17. Total 115.

Mount Pleasant.—Forest trees 8, shrubs 20, climbers 11, herbaceous 18, parasites 2, ferns 27, mosses, etc., 14. Total 100.

Port Hills.—Shrubs 18, herbaceous 88, ferns 15, mosses 10. Total 131.

Sand Hills.—Shrubs 11, herbaceous 59, ferns 4, mosses 2. Total 76.

Swamps.—Shrubs 14, herbaceous 86, ferns, etc., 9, mosses, etc., 7. Total 116.

[The following Lists have been compiled from those attached to Mr. Armstrong's paper, as giving the same information in a more connected form: the author gave a separate List for each district.—Ed.]

Forest Trees.	Native or Settlers' Name.	Season of Flowering.	Riccarton Bush.	Dry Bush.	Mount Pleasant Bush.	Port hills, and Sumner: north side of range.	Swamps.	Sand-hills.
Pittosporum eugenioides .	Tarata	Oct.	1	1				
Plagianthus betulinus .	Ribbon wood	Nov.	1					
Aristotelia racemosa .		Nov.		1				
Elæocarpus dentatus .	Hinau	Nov.-Dec.	1		1			
„ Hookerianus .	Small Hinau	Dec.	1					

Forest Trees.	Native or Settlers' Name.	Season of Flowering.	Riccarton Bush.	Dry Bush.	Mount Pleasant Bush.	Port hills, and Sumner: north side of range.	Swamps.	Sand-hills.
Alectryon excelsum	Titoki	Nov.-Dec.		1				
Sophora tetraptera, var.	Kowai	Oct.-Nov.		1				
Carpodetus serratus		Dec.	1	1				
Leptospermum scoparium	Manuka	Nov.-Dec.		1				
Fuchsia excorticata	Konini	Nov.-Jan.		1	1			
Panax crassifolium	Ivy tree	Nov.-Dec.	1	1	1			
„ longissimum	Horoeka		1					
„ simplex				1				
Schefflera digitata	White wood	Nov.	1	1	1			
Grisilinea littoralis	Broad leaf	Oct.-Nov.		1	1			
Myrsine Urvillei	Matipo	Oct.-Dec.	1	1	1			
Epicarpurus microphyllus	Towai	Dec.		1				
Podocarpus Totara	Totara	Nov.-Dec.	1	1	1			
„ ferruginea	Black pine Mairo	Dec.	1	1				
„ spicata	Maii	Nov.-Dec.	1					
„ dacrydioides	White pine Kahikatea	Nov.	1					
Cordyline australis		Dec.-Jan.			1			
Shrubs and Small Trees.								
Drymis axillaris	Pepper tree Horopita	Nov.-Dec.	1	1	1			
Melicytus ramiflorus	Hina hiua	Nov.-Jan.	1	1	1	1		
Pittosporum tenuifolium	Karo	Nov.-Jan.	1	1	1			
„ Colensoi		Oct.-Jan.	1	1				
Hoheria populnea	Ribbon wood Hohere	Nov.-Dec.	1	1	1			
Aristotelia racemosa	Wine berry	Oct.-Nov.	1		1			
Melicope simplex		Nov.-Jan.	1	1	1			
Pennantia corymbosa		Nov.-Jan.	1	1				
Discaria Toumatou	Toumatou	Nov.-Dec.		1		1	1	1
Plagianthus divaricatus		Dec.				1		
Coriaria ruscifolia	Tutu	Nov.-Jan.	1	1		1		1
Carmichælia australis	Makaka	Nov.-Dec.	1	1		1	1	1
„ juncea		Nov.-Dec.		1				
„ nana		Nov.-Dec.					1	1
„ pilosa		Nov.					1	
„ grandiflora		Oct.-Dec.					1	
„ sp.		Nov.-Dec.					1	
Sophora tetraptera, var. microphylla		Oct.-Dec.		1				1
Haloragis alata	Toa toa	Oct.-Jan.		1	1	1	1	1
Leptospermum scoparium, var	Manuka	Nov.-Dec.	1	1	1	1	1	
„ ericoides		Nov.-Dec.		1				
Myrtus obcordata	Myrtle	Nov.-Dec.	1	1	1			
„ pedunculata	Rohutu	Dec.	1					

Shrubs and Small Trees.	Native or Settlers' Name.	Season of Flowering.	Riccarton Bush.	Dry Bush.	Mount Pleasant Bush.	Port hills, and Sumner: north side of range.	Swamps.	Sand-hills.
Fuchsia excorticata .	Konini	Nov.-Dec.	1			1		
,, Colensoi. .		Nov.-Jan.	1	1				
Griselinia lucida . .	Broad leaf	Oct.	1					
Corokia Cotoneaster .		Nov.-Dec.	1	1	1			
Coprosma lucida . .	Kakaramu	Nov.	1	1	1	1		
,, robusta. .	Karamu	Nov.	1	1				
,, Cunninghamii .		Sept.-Oct.	1		1			
,, spathulata .		Sept-Nov.	1	1	1			
,, rhamnoides .		Sept.-Oct.	1	1		1		
,, rotundifolia .		Oct.-Nov.	1	1	1			
,, cuneata. .		Oct.	1					
,, parviflora .		Sept.	1					
,, acerosa . .		Oct. - Jan.				1	1	1
Olearia virgata . .							1	
,, nitida . .		Oct. - Jan.		1				
,, Forsteri . .	Akepirau	Nov.-Jan.		1				
Ozothamnus glomeratus .		Nov.-Dec.		1				
Cyathodes acerosa .	Mingi	Nov.-Dec.			1	1		
Cassinia Vauvilliersii .		Dec.-Feb.				1	1	1
,, leptophylla .		Nov.-Jan.						1
Muhlenbeckia complexa .		Nov.-Jan.				1		
Leucopogon Frazeri .		Nov.				1	1	
Sophora tetraptera, var. .		Oct.-Nov.				1		
Veronica salicifolia .		Nov.-Feb.		1	1		1	
,, Lavaudiana .		Dec.				1		
,, Colensoi. .		Dec. - Jan.		1	1			
,, Raoullii. .		Dec.				1		
Myoporum lætum. .	Ngaio	Dec.-Jan.	1	1	1			
Teucridium parvifolium .		Nov.-Dec.		1				
Urtica ferox . .	Ongonga	Nov.-Dec.	1	1	1			
Piper excelsum . .	Kava-kava	Nov.-Feb.		1	1			
Pimelia prostrata . .		Dec.					1	1
,, arenaria . .	Antetaranga	Nov.-Jan.						1
Parasites.								
Loranthus micranthus .		Nov.-Jan.		1				
Tupeia antarctica . .		Nov.-Jan.		1	1			
Viscum Lindsayi . .		Nov.-Jan.		1				
Creepers.								
Clematis indivisa . .	Traveller's joy	Nov.	1	1	1			
,, Colensoi. .		Nov.	1					
,, parviflora .		Nov.-Jan.						1
,, fœtida . .		Nov.		1	1			
,, n. sp. . .		Oct.-Nov.		1				
Rubus australis . .	Tataramoa	Nov.-Dec.	1	1	1			
Motrosideros scandens .	Akakura	Dec.	1	1	1			

CREEPERS.	Native or Settlers' Name.	Season of Flowering.	Riccarton Bush.	Dry Bush.	Mount Pleasant Bush.	Port hills, and Sumner: north side of range.	Swamps.	Sand-hills.
Passiflora tetrandra .	Kohea	Dec.		1	1			
Parsonsia albiflora .	Kaika	Dec.	1	1	1			
„ rosea . .		Dec.	1	1	1			
Convolvulus Tuguriorum .		Nov.-Dec.	1	1	1			
„ Sepium .		Nov-Mar.			1			
Muhlenbeckia adpressa .		Nov.-Feb.	1	1	1			
„ complexa .		Nov.-Jan.	1	1	1			
Rhipogonum scandens .	Supple-jack	Nov.	1					
HERBACEOUS PLANTS.								
Ranunculus pinguis .	Kori kori	Nov.-Jan.	1	1	1	1	1	1
„ macropus .		Oct. - Feb.	1			1	1	
„ lappaceus .	Butter cup	Nov.-Jan.				1		
„ plebeius .		Dec. - Feb.					1	
„ multiscapus .		Nov.-Feb.					1	1
Cardamine hirsuta .	Panapana	Sept.-Jan.	1	1	1		1	1
Viola Cunninghamii .	Violet	Sept-Mar.				1	1	
Stellaria media . .	Chickweed	Aug.-Ap.				1	1	
Colobanthus, sp. . .		Nov.		1		1		
Hypericum gramineum .	St. John's wort	Nov.-Jan.				1		1
„ japonicum .		Dec. - Jan.				1	1	1
Linum monogynum .	Flax	Nov-Mar.				1		
Geranium dissectum .	Pinaki tere	Nov.-Dec.	1	1		1	1	1
„ microphyllum .		Nov.-Feb.		1		1		
Pelargonium australe .	Kopata	Nov.-Dec.		1		1		1
Oxalis corniculata .		Nov.-Feb.	1	1		1	1	
Acæna Sanguisorbæ .	Burr Hutiwai	Nov.-Jan.	1	1		1		
Geum urbanum . .	Kopato	Oct.-Jan.		1		1	1	1
Potentilla ansorina, var. .		Nov.-Dec.					1	1
Drosera spathulata .	Sun dew	Jan.					1	
„ binata . .		Jan.					1	
Myriophyllum variæfolium		Feb.					1	
Gunnera monoica . .		Nov.-Feb.						1
Epilobium macropus .		Oct.-Dec.	1	1		1	1	1
„ nummularifolium	Hinatoti	Nov.-Dec.	1	1		1		1
„ rotundifolium .		Nov.-Jan.		1	1	1	1	
„ pallidiflorum .		Nov.-Jan.	1	1	1	1	1	1
„ Billardierianum		Nov.-Feb.	1					
„ purpuratum .		Oct.-Feb.				1		
„ crassum .		Nov-Mar.					1	
„ glabellum .		Oct.-Dec.						1
Aciphylla squarrosa .	Spear grass	Nov.-Dec.		1		1	1	1
Eryngium vesiculosum .	Sea holly	Nov.-Feb.					1	1
Ligusticum, sp. . .		Dec.				1		
Angelica Gingidium .		Nov.-Dec.		1		1		

Herbaceous Plants.	Native or Settlers' Name.	Season of Flowering.	Riccarton Bush.	Dry Bush.	Mount Pleasant Bush.	Port hills, and Sumner: north side of range.	Swamps.	Sand-hills.
Angelica geniculata		Dec.		1	1	1		
Galium tenuicaule		Nov.-Dec.					1	1
Celmisia longifolia		Nov.-Jan.				1	1	
Vittadinia australis		Nov.-Dec.				1	1	1
Daucus brachiatus	Wild carrot	Dec.				1		
Lagenophora Forsteri		Oct.-Jan.				1		
" petiolata		Oct.-Jan.				1		
Cotula coronopifolia		Nov-Mar.					1	
" australis		Sept-Mar.				1		
Brachycome Sinclairii	Daisy	Nov.-Jan.				1		
Craspedia fimbriata		Sept.-Feb.				1	1	1
" alpina		Oct.-Jan.				1		
Raoulia australis		Nov.-Dec.				1		
" Monroi		Nov.					1	
" sp.		Nov.				1		
Gnaphalium luteo-album		Nov.-Dec.	1			1	1	1
" bellidioides		Nov.-Dec.				1		
" filicaule		Nov.-Dec.				1		
" involucratum		Dec.	1			1		1
Erechtites arguta		Dec.-Ap.					1	
" quadridentata	Pekapeka	Oct.-Jan.				1		
Senecio bellidioides		Nov.-Jan.			1	1		1
" saxifragoides		Nov.-Feb.				1		
" lautus		Nov.-Jan.				1	1	
" lagopus		Dec.-Jan.					1	
Microseris Forsteri		Oct.-Jan.	1			1	1	1
Crepis Novæ Zelandiæ		Sept.-Feb.				1	1	
Taraxacum dens-leonis		Oct.-Apil.	1			1	1	1
Sonchus oleraceus	Sow thistle	Nov.-Mar.	1	1		1	1	1
Wahlenbergia gracilis	Blue bell	Oct.-Jan.	1			1	1	1
Pratia angulata		Dec.					1	
" sp.		Nov.-Mar.				1		
Lobelia, sp.		Dec.-Feb.					1	
Selliera radicans		Oct.-Jan.				1	1	1
Leucopogon, sp.		Nov.-Jan.						1
Samolus repens		Dec.-Jan.					1	1
Gentiana montana		Dec.-Feb.					1	
Sebæa ovata		Dec.-Feb.				1	1	1
Myosotis Forsteri	Forget me not	Nov.-Jan.				1		
" australis		Dec.					1	
" sp.		Nov.-Jan.					1	
Convolvulus sepium	Bind-weed	Nov.-Jan.				1		
" tuguriorum		Nov.-Feb.				1		
" erubescens		Oct.-Jan.				1	1	
Dichondra repens		Nov.-Dec.				1		
Solanum nigrum	Nightshade	Sept.-Jan.	1	1	1	1	1	

Herbaceous Plants	Native or Settlers' Name.	Season of Flowering.	Riccarton Bush.	Dry Bush.	Mount Pleasant Bush.	Port hills, and Sumner: north side of range.	Swamps.	Sand-hills.
Solanum aviculare .	Koho koho	Nov.-Dec.	1	1	1			
Mentha Cunninghamii .	Mint	Nov.-Jan.				1	1	1
Plantago major . .	Plantain	Oct. - Feb.	1			1	1	
„ Raoulii . .		Nov.-Jan.					1	1
Chenopodium triandrum .	Spinach	Nov.-Jan.				1		
„ urbicum .		Nov.-Jan.			1			
„ glaucum .		Nov.						1
Atriplex cinerea .		Nov.-Jan.					1	1
Scleranthus biflorus .	Kohu kohu	Nov.-Dec.				1		1
Polygonum aviculare .	Pigweed	Oct. - Mar.	1			1	1	
Rumex flexuosus . .	Dock	Nov.-Jan.	1			1		1
Euphorbia glauca . .	Spurgewort	Nov.-Dec.				1		
Urtica incisa . .	Nettle	Nov.-Mar.	1		1		1	
Earina mucronata . .		Dec. - Feb.				1		
Corysanthes macrantha .		Nov.			1	1		
„ triloba .		Nov.			1			
„ oblonga .		Nov.				1		
Thelymitra longifolia .		Dec.				1	1	1
Phrasophyllum Colensoi .		Dec.				1	1	1
Four other orchids .								1
One „ .							1	
Libertia ixioides . .	Turutu	Nov.-Jan.	1	1	1	1		
„ grandiflora .		Nov.-Jan.					1	
Hypoxis pusilla . .		Nov.-Apl.					1	
Anquilaria Novæ Zelandiæ		Nov.					1	
Typha angustifolia .		Nov.-Apl.					1	
„ latifolia . .	Raupo	Dec.-Mar.					1	
Lemna minor . .							1	
Potamogeton natans .							1	
Cordyline Pumilio .	Tirauriki		1					
Astelia nervosa . .		Sep. - Oct.	1	1	1	1	1	
Arthropodium candidum .		Nov.-Dec.				1	1	
Anthericum Hookeri .		Nov.-Dec.				1	1	1
Phormium tenax . .	N. Z. flax	Nov.-Dec.	1			1	1	
„ Colensoi .		Dec. - Jan.					1	
Juncus vaginatus . .		Nov.				1	1	
„ australis . .		Oct.					1	1
„ maritimus .	Wiwi	Oct.				1	1	1
„ communis .	Common rush	Oct. - Nov.	1				1	1
„ Holoschœnus .		Nov.						1
„ sp. . .		Oct.					1	
Luzula campestris . .		Oct. - Nov.	1	1	1	1	1	1
„ Oldfieldii . .		Oct. - Dec.	1			1	1	
„ crinita . .		Oct.					1	1
„ sp. . .		Oct.						1
Leptocarpus simplex .	Oi oi	Nov.					1	1

Herbaceous Plants.	Native or Settlers' Name.	Season of Flowering.	Riccarton Bush.	Dry Bush.	Mount Pleasant Bush.	Port hills, and Sumner: north side of range.	Swamps.	Sand-hills.
Eleocharis gracilis .		Nov.				1	1	1
Desmochœnus spiralis .	Pingao	Nov.						1
Gahnia xanthocarpa .	Cutting grass	Nov.-Dec.	1					
Lepidosperma tetragona .		Nov.				1	1	1
Carex ternaria . .	Rautahi	Oct.	1	1	1	1	1	1
„ breviculmis . .		Oct.				1		1
„ virgata, var. secta .		Oct.-Nov.					1	
„ Raoulii . .		Nov.	1					1
„ sp. . .		Nov.						1
Microlæna polynoda .					1		1	
Alopecurus geniculatus .		Oct.-Nov.					1	
„ (Phleum) pratense		Oct.				1		
Hierochloe redolens .	Koretu	Oct. - Dec.	1				1	
Deschampsia cæspitosa .		Nov.				1	1	1
Agrostis quadriseta .		Nov.				1		
Apera arundinacea .	Hoomanga-moka	Oct.		1	1			
Arundo conspicua .	Toi toi	Nov.-Dec.	1			1	1	1
Poa foliosa . .		Oct. - Dec.				1		
Festuca duriuscula .		Oct. - Jan.				1	1	
Ferns.								
Cyathea dealbata .					1			
Dicksonia lanata .			1					
„ squarrosa .			1		1			
Hypolepis tenuifolia .			1		1			
„ distans .					1			
Adiantum Cunninghamii .					1			
Cheilanthes Sieberi .					1	1		
Pellæa rotundifolia .			1	1	1	1		
Pteris aquilina, var. esculenta . .			1	1	1	1	1	1
Pteris scaberula . .							1	
„ incisa . .							1	
Lomaria procera . .			1	1	1	1	1	
„ fluviatilis .			1	1	1	1	1	
„ vulcanica .					1			
„ lanceolata .					1			
„ discolor . .			1		1			
„ alpina . .			1	1	1	1	1	1
Asplenium obtusatum .					1			
„ lucidum .						1		
„ bulbiferum .			1	1	1	1		
„ flaccidum .			1	1	1			
„ flabellifolium .				1	1			
„ Hookerianum .				1	1			
Aspidium aculeatum .			1	1	1	1		

FERNS.	Native or Settlers' Namd.	Season of Flowering.	Riccarton Bush.	Dry Bush.	Mount Pleasant Bush.	Port hills, and Sumner: north side of range.	Swamps.	Sand-hills.
Aspidium oculatum .						1		
Nephrodium velutinum .					1			
„ decompositum				1	1			
Polypodium Grammitidis .					1			
„ rupestre .			1	1	1	1		
„ pennigerum .					1			
„ Billardieri .			1	1	1	1		
Leptopteris hymenophylloides . .	Heru heru		1		1			
Gymnogramme leptophylla						1		
Ophioglossum vulgatum .						1	1	1
Botrychium virginicum .						1	1	1
MARSILEACEÆ.								
Azolla rubra . .							1	
MOSSES, LICHENS, FUNGI, ETC.								
Leucobryum candidum .			1	1	1			
Dicranum dicarpon .				1	1	1		
Campylopus introflexus .			1	1	1			
Ceratodon purpureus .			1	1	1			1
Macromitrium erosulum .			1	1	1			
Bryum truncorum .			1	1	1	1		
Hookeria pulchella .			1	1	1			
Funaria hygrometrica .			1	1		1	1	1
Isothecium ramulosum .			1	1	1			
Hypnum relaxum .			1	1	1			
„ sp. . .			1	1	1			
Sticta aurata . .			1		1	1		
„ crocata . .			1					
„ latifrons . .			1	1	1			
„ filicina . .			1	1	1			
Polytrichum sp. . .			1	1				
Chara sp. . .							1	
Agaricus campestris .	Common mushroom		1	1		1	1	
„ sp. . .			1					
Geaster fimbriatus .				1				
Ileodictyon cibarium .			1			1	1	
„ gracile .			1			1	1	
Lycoperdon Novæ Zelandiæ				1	1	1	1	
„ pyriforme .							1	
„ sp. . .						1		
Polyporus sp. . .			1	1	1			

Art. XXV.—*On Irrigation as applied to the growth of* New Zealand Flax.

By J. C. Crawford, F.G.S.

[*Read before the Wellington Philosophical Society, August* 14, 1869.]

There is no country in the world which rejoices in more numerous sparkling streams than New Zealand, and in this respect it contrasts remarkably with the neighbouring territory of Australia; but the rivers are seldom navigable to any distance from the coast, and their waters generally reach the sea without proving of more utility to mankind, than for the common supply of liquid for daily consumption.

There are two modes by which the streams may be made useful to mankind.

1. By forming reservoirs of power.
2. By fertilizing the soil by irrigation.

It is my intention at present to consider the latter point only.

In Europe two systems of irrigation are adopted. In the warm climates of the Mediterranean basin, water is conveyed to the fields under crop, for the simple purpose of providing the necessary moisture.

In the colder latitudes of England, France, and Germany, water-meadows are put under irrigation during the winter season, at a time when, *primâ facie*, one might suppose that the soil was sufficiently moist. These meadows are laid out on two plans: on level ground they are formed into ridges and furrows—the water running on to the ground along conduits on the top of the ridges; then flowing gently over both sides, is carried away by the drain in the furrow. To lay off land carefully in this manner is expensive, but the returns are very great. On uneven ground the catch meadow system is adopted. Advantage is taken of the inequalities of the ground to run the water as evenly as possible over the surface, and with proper skill and judgment this object is often attained at slight outlay.

It is a remarkable fact, that although the fertility of water meadows is vastly increased by an admixture of manure with the water, yet that water, containing apparently no foreign element of fertility, is capable, when applied to the soil, of enabling it to return, year after year, heavy crops of hay and grass. This is a point which science has not, as yet, thoroughly explained.

As examples of irrigation I will mention the water meadows near Edinburgh, which are irrigated by strong town sewage. These meadows produce frequent heavy crops of grass, and are said to make a return of from £20 to £60 per annum, according to distance from the fertilizing sources, and the nature of the soil. In Wiltshire, Berkshire, and many other counties in the south of England, the return from water meadows, irrigated without sewage, is very large, and I think that, at a moderate estimate, a return of from £5 to £7 per acre may be considered the average.

The meadows provide early grass for the ewes and lambs in spring, a heavy cut of hay in summer, and an aftermath in autumn.

From my own experience, in a cold district in Scotland, I may state, that after throwing the drainage water from the upper part of my property, so as to irrigate some fields on the lower part, I have obtained, ever since, an increased return, of some 75 per cent. from the irrigated portion, over the previous rental.

In New Zealand, and in no part of the country more than in the Province of Wellington, there are facilities for irrigation possessed by few other countries. It would be absurd to advise expensive modes of laying off land for irrigation, in the present sparse state of the population of the colony; but if it should appear that large tracts of country may be irrigated at moderate expense, for the purpose of developing a staple export, the subject is at least worth enquiry. The export of the fibre of the *Phormium tenax* has

almost now become a settled industry, and although we may expect this year to hear of many samples being sold below cost price, on account of bad preparation, yet there is reason to suppose that all well-got-up samples will fetch remunerative prices.

Should this industry prove successful, it will clearly be necessary that the cultivation of the plant shall be proceeded with on a large scale, and no one who has observed the growth of the plant, but will have perceived the enormous advantage which irrigation may produce in the returns to be derived from it. If a drain be cut through a flax swamp, and the stagnant water thereby set in motion, the stunted flax, of 18 inches or 2 feet high, immediately springs up to a height of 8 to 10 feet. It is said that in the old days of Maori flax cultivation, the plants were irrigated, although always planted on a hill side.

There is, I should think, no disputing the point that irrigation would add immensely to the returns to be derived from flax cultivation.

It remains, therefore, to be considered what districts in this province are most favourable for irrigation.

Excluding, at present, any small valleys in this immediate vicinity, and proceeding to more extensive districts, we find a low-lying country of sand-hills, swamps, and alluvial flats, extending from the coast at Paikakariki to the Rangitikei river. This country is intersected by streams and rivers, and a great quantity of, at present, comparatively valueless land, might, by irrigation, be made to yield a large annual return. Among the rivers on this coast, the Manawatu might be used for what is called *warping*—that is, it might be made to deposit its sediment over unfertile tracts of sand.

On the Wairarapa side, extensive stony plains, which, without irrigation, can never produce much beyond a scanty herbage, might, by the fertilizing power of water, be made some of the most valuable lands of the colony.

To produce the results proposed will require both capital and skill; but, if the fibre of the *Phormium tenax* is to become a great staple export of this country, both of these must be found. If they are not procurable in the colony they must be imported. At the same time, laying off the land for flax irrigation would, probably, not be expensive.

Irrigation, once introduced, would be found to assist materially in the growth of numerous productions, and would, by no means, be confined to the growth of flax alone. Probably few persons in this province are aware that irrigation is at present carried on with marked success in the interior of the Province of Otago. Water-races, which have been brought into auriferous localities for the extraction of gold, are partially used for the promotion of the production of herbs and corn, and the enormous turnips, and other vegetables, which I have seen produced by this means, are enough to astonish a beholder.

I have pointed out the districts in this part of the island to which I consider irrigation might be most advantageously applied. They are low-lying compared with the levels of the streams. In other parts of the country, with the exception of the immediate banks of the rivers, the land rises too rapidly towards the interior to admit of the requisite facilities for the watering of its surface, unless at an expense which is not, in this generation, likely to be incurred.

Let us, however, remember the Spanish proverb:

> "*En Andalusia la carne es yerba,*
> *La yerba es agua,*
> *Los hombres son mujeres,*
> *Y las mujeres nada.*"
>
> In Andalusia flesh is herb,
> Herb is water,
> Men are women,
> And women are *nothing.*

Andalusia is a province in which irrigation is largely carried on.

Lest this proverb should produce any damaging effect upon our proposed scheme of irrigation, I may mention that I breakfasted one morning in Cadiz, and, that, so far as I could judge from such a cursory glance, the men were sturdy, and the women beautiful; besides which, I have had opportunities at Gibraltar, of observing the race with a satisfactory result.

ART. XXVI.—*On the* NATURALIZED PLANTS *of New Zealand, especially with regard to those occurring in the Province of Auckland.** By T. KIRK.

[*Read before the Auckland Institute, November* 15, 1869.]

PART I.

IN the present imperfect knowledge of the laws which regulate the distribution of species, any authenticated records of the introduction of exotic species into new countries, and their subsequent diffusion, must of necessity possess high value, and be alike calculated to throw light on the obscure past, and to prevent the adoption of error in the future. The opportunities afforded by modern colonization, of watching the introduction of foreign species, and noting their diffusion in new countries, by agencies uncontrolled by man, have been, to a great extent, neglected. In truth, it is far easier to recognize results, than to watch the processes by which the results are brought about; a few years sometimes suffice to show us the displacement of the greater portion of the vegetation of certain localities, although the process itself has been so gradual as almost to have escaped notice; yet when, as in these islands where settlement is in its infancy, we find much of the original vegetation displaced by non-indigenous plants, established about the early mission stations, and seats of commerce, about mines, timber stations, and cattle runs, in short, wherever the immigrant has fixed his temporary or permanent home; we are insensibly led to entertain wider views of the changes which the floras of countries of ancient civilization must have undergone by successive immigrations of plants from other countries. In this light we may glance for a moment at the flora of the British Islands, the flowering section of which is supposed by botanists to consist of naturalized plants to the extent of from one-seventh to one-fourth, or even a higher proportion. If we look back to the time of Phœnician commerce and settlement in the western part of the island, we can readily conceive of plants, from the countries on the Euxine and the Mediterranean, having been accidentally introduced and amalgamated with the indigenous flora. In later times we have no difficulty in extending the idea to those countries which sent to Britain successive hordes of invaders; and in the present day we can point to plants and animals, alike of accidental introduction in the footsteps of commerce, which have become widely naturalized; take for examples, *Impatiens fulva*, *Elodea alsinastrum*, and the fluviatile mollusk *Dreissena polymorpha*.

Now although the robust growth of the modern civilization has buried many traces of the less vigorous ancient forms, it would seem not utterly impossible that a more careful and comparative examination than has yet been made of the floras of the countries, from which Britain received her ancient settlers and invaders, might lead to the removal of much of the uncertainty and doubt that exist as to the indigenous or exotic origin of so large a proportion of her flora; and might also show, to some extent, what those countries had received from Britain, and from each other. To apply this in

* On the subject of Introduced Plants in New Zealand, see Paper by Dr. Hooker, F.R.S., and W. Locke Travers, F.L.S., in "Natural History Review," Vol. iv., pp. 123 and 617, 1864.—ED.

the case of New Zealand: it is but a century since the islands were discovered by Cook; less than sixty years since the early visits of whalers, and the establishment of the first mission stations; and not half that period has elapsed since settlement was commenced in a systematic manner, yet already the number of naturalized plants,—that is to say, of non-indigenous plants propagating their species, and becoming diffused without the intentional agency of man, or even in opposition thereto, in the Province of Auckland alone,—is equivalent to fully thirty per cent. of the entire number of flowering plants found within the limits of the Colony; a proportion equalling, as we have already seen, that which exists in the British Islands, with a commerce dating from a period anterior to the Christian era. Some of these introductions have largely displaced the original vegetation in many localities, from the North Cape to the Bluff; from the sea level to the highest spots on the hills trodden by the miner or shepherd; while others are confined to a limited area, and apparently exercise no direct influence on the original flora.

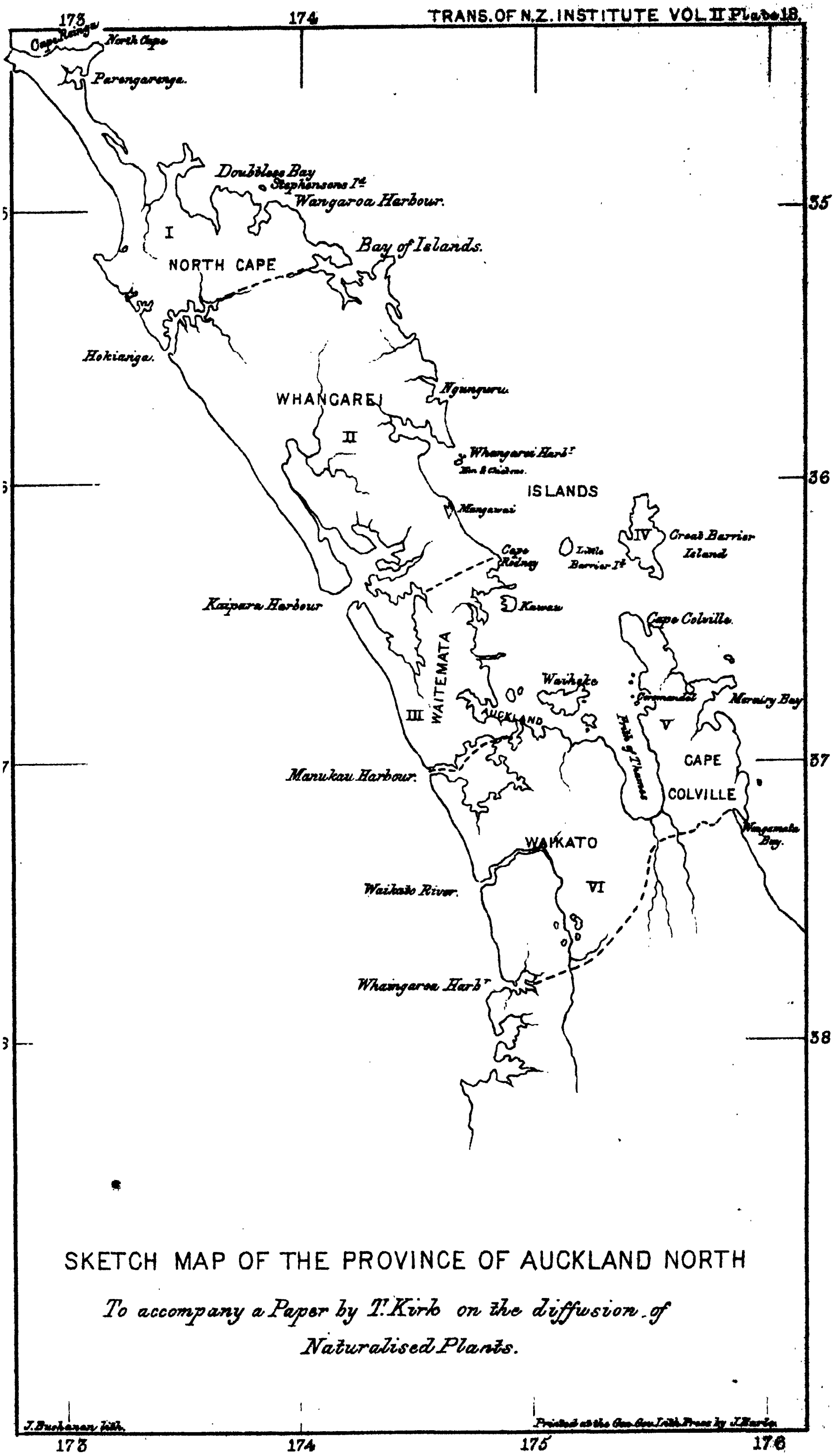
A reliable account of the present state of even a few species is a contribution of no small value, tending to prevent the uncertainty and confusion with regard to the geographic origin of a large portion of the flora, which we have seen to prevail so largely in countries of old commerce and civilization, affording a starting point for measuring the rate of diffusion, and noting the power of displacement of, or amalgamation with, the original flora; and in this and other points preparing important material for unlocking the histories of past immigrations in other countries.

The object of this paper is simply to place upon record the present state of the diffusion of naturalized plants in this province, as fully as the available material will allow, with a due regard to conciseness. In those cases where the species under notice is known to occur in other parts of the colony, the facts will be mentioned, but, unhappily, these are far too few to admit of this sketch being considered anything more than a sketch of the naturalized plants of the Province of Auckland.

For the facts recorded in this paper, the writer is personally responsible, except when otherwise stated; the only published accounts available, are a list of about sixty species given in "Flora Novæ Zelandiæ," Vol. ii.; a list of about one hundred and seventy species in the "Handbook of the New Zealand Flora,"—the additions comprised in which, were largely contributed by the present writer; and lists of the naturalized plants of the Great Barrier Island, and other localities, prepared by him, and published in the "Transactions of the New Zealand Institute," Vol. i.

Many important bearings of this subject will, it is hoped, afford material for future study. The increased diffusion of certain of the indigenous species by external agencies, only called into operation since the settlement of the colony; the possible introduction of a few additions to the original flora, by the Maori race; the displacement of a portion of the original species; the spontaneous amalgamation of introduced and native species for the benefit of man; the relative statistical importance of the naturalized species to each other, and to the indigenous flora; the influence of climatal and geognostic conditions in facilitating or retarding distribution, and in developing aberrations from the original type, are attractive subjects of vast importance to the phyto-geographical student, and *at the present time* could probably be worked out more clearly and with greater precision for this colony than for any other country whose flora is equally well determined, owing to the small admixture of error with the facts upon which the student must base his conclusions.

The following plan has been adopted for expressing the known facts for each species, in a concise manner, and admits of ready adaptation for other districts.



SKETCH MAP OF THE PROVINCE OF AUCKLAND NORTH

To accompany a Paper by T. Kirk on the diffusion of Naturalised Plants.

I.—Extent of diffusion.

With the view of indicating, as precisely as practicable, the present diffusion of each species, the Province of Auckland, as far south as Ngaruawahia, has been divided (somewhat arbitrarily) into districts, as under:—

1. *North Cape*:—from Cape Maria Van Dieman and the North Cape, to Hokianga and the Bay of Islands.

2. *Whangarei*:—from Hokianga and the Bay of Islands, to Cape Rodney and the north head of the Kaipara harbour.

3. *Waitemata*:—from the south head of the Kaipara, and Cape Rodney, to the head of the Manukau harbour at Penrose, and the Tamaki at Panmure.

4. *The Islands*:—including the Cavalhos and Taranga groups, the Great and Little Barriers, etc., the Kawau, and those in the Firth of Thames.

5. *Cape Colville*:—the Cape Colville peninsula as far south as Kawaeranga and Wangamata Bay.

6. *Waikato*:—from Penrose and Panmure to Whaingaroa and Ngaruawahia.

The district in which each species is known to occur will be indicated by the use of the numbers prefixed above; thus practically affording a separate list of the naturalized plants of each district; but it must not be supposed that these lists are complete, even for any one district. The naturalized plants of the western side of the North Cape district are quite unknown to the writer, and to a great extent those of the western side of the Whangarei district. The districts for which the lists are most complete, are Auckland, the Islands, and Cape Colville. Very little is known of the naturalized plants of the western and extreme southern divisions of the Waikato district, or of the East Coast, south of Wangamata Bay.

II.—Introduction of Plants.

This has evidently been effected by two chief causes; the direct agency of man, for the purposes of cultivation; and the indirect agency of man and the lower animals, etc.

The first head may be sub-divided into:—

1. *Horticultural* (Hor.),* remains of, or escapes from garden cultivation, as *Pelargonium quercifolium*, *Iris germanica*.

2. *Agricultural* (Agri.), remains of, or escapes from, field cultivation, as *Lolium perenne*, *Trifolium repens*.

3. *Accidental*. (Acc.) Under this head are included those plants unintentionally introduced by man, whether mixed amongst seeds of ordinary cultivated plants, as in the case of buck-wheat, corn cockle, etc.; or from the seeds being able to attach themselves to clothing, or to the skins of animals, as the various docks, mallows, etc.; or from less prominent causes: in this way *Erigeron canadensis* has been carried all over the world.

4. *Uncertain*. (Unc.) Plants introduced by causes not directly referable to either of the above.

III.—Degree of Establishment.

As has already been stated, there is a wide difference in the degree to which naturalized plants have adapted themselves to the new conditions under which they are placed. It is attempted to estimate the extent of this adaptiveness by the application of the following terms:—

1. *Denizen*. (Den.) Plants thoroughly established, and spreading widely without assistance from man; often displacing indigenous forms to a great extent, or readily amalgamating with native species, as *Trifolium minus*, *Erigeron canadensis*, *Poa annua*.

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* The abbreviations in parentheses are employed in the list.—Ed.

2. *Colonist.* (Col.) Plants which maintain their ground where introduced, increase with more or less rapidity, but do not displace native species to any great extent, as *Œnothera stricta, Tragopogon porrifolius.*

3. *Alien.* (Ali.) Plants which maintain their ground where introduced, but are obviously incapable of wide diffusion, except by the direct agency of man, as the fig, potato, tomato, etc.

IV.—HABITAT.

In order to afford a concise description of the usual habitat of each species, the following series of terms has been adopted, as they are for the most part identical with those employed for the same purpose in another paper, a brief explanation only is requisite.*

1. *Littoral.* (Lit.) Plants of the sea-shore, whether growing on sand or mud.
2. *Ericetal.* (Eri.) Plants of dry open land.
3. *Pascual.* (Pas.) Plants of grassy land, paddocks, etc.
4. *Agrestal.* (Agrc.) Plants of cultivated land.
5. *Rupestral.* (Rup.) Plants growing on or amongst rocks.
6. *Viatical.* (Via.) Plants growing on waste places, or by road sides, etc.
7. *Inundatal.* (Inu.) Plants growing by the sides of streams and other places liable to inundation.
8. *Paludal.* (Pal.) Plants usually growing in wet soil, or in water.
9. *Lacustral.* (Lac.) Aquatic plants, submerged or floating.
10. *Septal.* (Sep.) Plants of thickets and hedge-rows.
11. *Sylvestral.* (Syl.) Forest plants.

V. DURATION.

A. *Annual.* B. *Biennial.* P. *Perennial.*

It will occasionally occur that a variety of information which cannot properly be placed under either of the preceding divisions is available, in which case it will be appended as a paragraph.

LIST OF NATURALIZED PLANTS

REPORTED TO OCCUR IN NEW ZEALAND,

WITH THE DISTRIBUTION OF THOSE FOUND IN THE PROVINCE OF AUCKLAND SHOWN IN DETAIL.

RANUNCULACEÆ.

Ranunculus acris, L., Europe, P., 2-3-4-6,† Acc. Den. Pas.

„ *repens*, L., Europe, P., 3-4, Acc. Den. Pas. Inu.

„ *parviflorus*, L., v. *australis*. Possibly introduced, according to Dr. Hooker. It has, however, the appearance of a truly indigenous plant, and as such it seems best to regard it.

PAPAVERACEÆ.

Papaver Rhœas, L., Europe, A., 1, Unc. Col. Via. Local. I have observed this plant in a solitary locality at the north-western extremity of the island; it may, however, be expected to occur commonly as an agrestal plant.

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* See ante, p. 96, On the Botany of the Thames Goldfield.
† The figures refer to districts.—See p. 133.

FUMARIACEÆ.

Fumaria parviflora, Lam. Mentioned in *Flora N. Z.* ii. I have not seen specimens.

Fumaria officinalis, L., Europe, A. 3, Acc. Col. Agre.

CRUCIFERÆ.

Nasturtium amphibium, L., Europe, P., 1-2-3-4-5-6. Hor. Den. Inu. Pal. Has spread throughout the islands. I am informed that it impedes drainage in some parts of the Province of Canterbury. In this province it is often found in localities which are dry during the greater part of the year.

Barbarea præcox, Br., Europe, A., 1-3-4. Hor. Den. Pas. Via. This has probably been mistaken for *B. vulgaris*, L., in some northern localities. It is usually biennial in Europe.

Sisymbrium officinale, L., Europe, A., 1-2-3-4-5-6. Acc. Den. Via.

,, *pannonicum*, Jacq., Europe, A., 4. Acc. Ali. Agre. Local. (Introduced with European flax ?)

Senebiera coronopus, Poir., Europe, A., 1-3-4. Acc. Col. Via.

,, *pinnatifida*, D.C., South America, A., 1-2-3-4-5-6. Acc. Den. Via. Lit.

Capsella Bursa-pastoris, L., Europe, A., 1-3-4-5-6. Acc. Col. Pas. Via.

Lepidium ruderale, L., Europe, A., 1-2-3-4. Acc. Col. Lit. Via., etc.

,, *sativum*, L., Europe, A., 1-2-3-4. Hor. Col. Via.

Alyssum maritimum, Willd., Europe, P. Mentioned in *Fl. N. Z.* ii. I have not seen recent wild specimens.

Cochlearia Armoracia, L., Europe, P., 3. Hor. Ali. Via., etc.

Sinapis nigra, L., Europe, A., 3-5. Acc. Col. Via. Local.

,, *arvensis*, L., Europe, A., 1-2-3-4-5-6. Acc. Col. Agre. Via.

Brassica Rapa, L., Europe, B., 1-2-3-4-5-6. Agri. Col. Agre. Via.

,, *Napus*, L., Europe, B., 2-3-4-5-6. Agri. Col. Agre. Via. Said to have been introduced by Cook.

Brassica oleracea, L., Europe, B., 3-4-5. Hor. Col. Lit. Via. This appears to be permanent in littoral situations only. Said to have been introduced by Cook.

Brassica campestris, L., Europe, B., 2-3-4-5. Agri. Col. Agre. Via.

Raphanus sativus, L., Europe, A. 1-2-3-4-5. Hor. Col. Lit. Probably introduced by Cook.

POLYGALACEÆ.

Polygala myrtifolia, L., Cape of Good Hope, P., 3. Hor. Ali. Sep., etc.

VITACEÆ.

Vitis vinifera, L., Caspian, P., 2-3-4-5. Hor. Ali. Syl., etc.

CARYOPHYLLEÆ.

Gypsophila tubulosa, Briss., Levant. I have not seen N. Z. specimens. Dr. Hooker considers it introduced, chiefly, I presume, on the ground of its restricted range in the northern hemisphere, and on the rapidity with which it is becoming diffused in Australia and New Zealand.

Silene quinquevulnera, L., Europe, A., 1-2-3-4-5-6. Hor. (?) Acc. (?) Den. Pas. Agre., etc. I believe this is also found in the Province of Canterbury, but am unable to state my authority. Said to have been introduced with grass seed from Chile ; it is, however, commonly cultivated in gardens.

Lychnis Githago, Lam., Europe, A., 3., Acc. Col. Agre. Local.

Stellaria media, With., Europe, A., 1-2-3-4-5-6. Acc. Den. Pas. Agre. Syl.,

etc. One of the very few naturalized plants found on the Little Barrier Island.

Arenaria serpyllifolia, L., Europe, A., 3. Unc. Col. Lit. Local. Confined to a solitary locality on the sandy beach at Koheroa, near Omaha, possibly a waif brought by the sea.

Sagina apetala, L., Europe, A., 3. Unc. Ali. Via. Only observed in a single locality, into which it has been latterly destroyed by traffic.

Cerastium vulgatum, L., Europe, A., 1-2-3-4-5-6. Acc. Den. (?) Col. (?) Pas. Via. This and a few other species require a term somewhat intermediate between "Denizen" and "Colonist," being sufficiently abundant and general to belong to the former, while their small size prevents their interference with the original vegetation, to any marked extent.

Cerastium viscosum, L., Europe, A., 1-2-3-4-5-6. Acc. Den. (?) Col. (?) Pas. Via. Rup. Observed at an altitude of 2000 feet.

Polycarpon tetraphyllum, L., Europe, A., 1-3-4-6. Acc. Den. (?) Col. (?) Lit. Via.

Spergula arvensis, L., Europe, A., 1-2-3-4. Acc. Col. Agre.

PORTULACEÆ.

Portulaca oleracea, L., Europe, 1-2-3-4. Hor. (?) Acc. Den. Lit. Agre. Often forming a compact sward in the immediate vicinity of the sea. A troublesome weed in rich cultivated land.

HYPERICINEÆ.

Hypericum Androsæmum, L., Europe, P., 6. Hor. Col. Via. Local.

" *perforatum*, L., Europe, P., 4-6. Acc. Den. Pas. Local but abundant.

Hypericum humifusum, L., Europe, P., 3. Acc. Col. Pas. Local.

MALVACEÆ.

Malva sylvestris, L., Europe, A., 6. Acc. Col. Pas. Local. This and the next species appear to be annual in N. Z., although biennial or perennial in the northern hemisphere.

Malva rotundifolia, L., Europe, A., 2-3-4-5-6. Acc. Den. Agre. Via.

" *caroliniana*, W., N. America, P., 1-2-3-4-5-6. Acc. Den. Via.

Lavatera arborea, L., Europe, P., 3-4-6. Hor. Col. Lit. Via.

LINEÆ.

Linum usitatissimum, L., Europe, A., 2-3-4. Agri. Acc. Col. Agre. Via.

GERANIACEÆ.

Geranium molle, L. Included in the list of naturalized plants given in the "Handbook," but should, I think, be considered indigenous, although its area may have been widened by introduction.

Pelargonium quercifolium, Ait., Cape of Good Hope. P., 2-3-6. Hor. Col. Via., etc.

Erodium cicutarium, L., Europe, A. (?), b. *charophyllum*, v. "*littorale*," 1-2-3-4-5-6. Acc. Den. Via. Found also in Marlborough, (Buchanan.) A remarkably variable plant; the leaflets in the typical are sometimes scarcely toothed and very broad, and in *var.* b. narrow-linear, closely resembling the garden Chervil, *var.* v. has almost entire leaves, more resembling *E. maritimum*, Sen., than the present species. It is confined to the Bay of Islands.

Erodium moschatum, Sm. Europe, A., 2. Acc. Col. Via. Local. Perhaps a form of the preceding species.

LEGUMINOSÆ.

Podalyria sericea, W., Cape of Good Hope, P., 3. Hor. Ali. Via. Local.
Eutaxia Strangeana, Turc., Australia. Not found in New Zealand, see "Handbook," p. 53.
Ulex Europæus, L., Europe, P., 1-2-3-4-5-6. Hor. Den. Via., etc.
Lotus corniculatus, L., Europe, P., 3-6. Acc. Col. Pas.
„ *major*, Scop., Europe, P., 3. Acc. Col. Pas. Uli.
Trifolium pratense, L., Europe, P., 1-2-3-4-5-6. Agri. Den. Agre. Pas., etc.
„ *medium*, L., Europe, P., 3-6. Agri. Col. Agre., etc.
„ *glomeratum*, L., Europe, A., 3. Acc. Col. Via., etc.
„ *repens*, L., Europe, P., 1-2-3-4-5-6. Agri. Den. Pas. Via.
„ *procumbens*, L., Europe, A., 2-3-4-5-6. Acc. (?) Agri. (?) Col. Pas., etc.
Trifolium minus, Sm., Europe, A., 1-2-3-4-5-6. Acc. Den. Pas. Via., etc.
Melilotus officinalis, Willd., Europe, B. or P., 3-4-5. Acc. Col. Pas., etc.
„ *arvensis*, Willd., Europe, P., 2-3-4-5-6. Acc. Den. Via., etc.
Medicago lupulina, L., Europe, A., 1-2-3-4-5-6. Agri. Den. Pas. Via., etc.
„ *maculata*, L., Europe, A., 2-3-4-5. Acc. Den. Pas., etc.
„ *denticulata*, Willd., Europe, A., 1-2-3-4-5-6. Acc. Den. Pas. Via., etc.
Psoralea pinnata, Willd., Cape of Good Hope, P., 3-6. Hor. Col. (?) Ali. (?) A plant frequently cultivated; as it seeds freely, small specimens are not uncommon in the neighbourhood of gardens, deserted homesteads, etc., where it can scarcely be expected to become fully naturalized.
Robinia Pseudacacia, Willd., North America, P., 3. Hor. Col. Via., etc. Would speedily become common, if not interfered with, as it increases by suckers, as well as by seeds. A striking instance may be seen on the Auckland and Drury railway, where it has established itself on an embankment, about four years since, and bids fair to form a grove.
Vicia sativa, L., Europe, A., 2-3-6. Acc. Col. Pas., etc.
„ *hirsuta*, Koch., Europe, A., 3. Acc. Col. Agre., etc
„ *tetrasperma*, Mœnch., Europe, A., 3-6. Acc. Den. Pas.
„ *gracilis*, Lais., Europe, A. *Fl. N. Z.*, ii. I have not seen N. Z. specimens.
Lathyrus odoratus, Willd., Europe, A., 3. Hor. Col. Syl., etc. Local.
Guilandina Bonduc, L., India, P., *Fl. N. Z.*, ii. Erroneously stated by Forster, to have been collected in New Zealand.
Acacia lophantha, Willd., Australia, P., 2-3-4-5-6. Hor. Col. Syl., etc.
„ *decurrens*, Willd., var. *dealbata*, Australia, P., 2-3-6. Den. Syl., etc.

ROSACEÆ.

Amygdalus persica, L., Persia, P., 1-2-3-4-5-6. Hor. Den. Syl., etc.
Prunus Cerasus, L., Europe, P., 2-3-4-5-6. Hor. Den. (?) Col. (?) Syl., etc.
Spiræa salicifolia, Willd., Europe, P., 3-6. Hor. Ali. Via., etc.
Rubus discolor, W. and N., Europe, P., 3-6. Hor. Den. Via., etc.
„ *rudis*, Weihe., Europe, P., 3. Hor. Col. Sep., etc. Local.
„ *Idæus*, L., Europe, P., 2-3-5-6. Hor. Den. Syl. Via., etc.
Fragaria vesca, L., Europe, B., 2-3-4-5-6. Hor. Den. Syl. Via., etc.
„ *elatior*, Ehrd., Europe, P. 5. Hor. Col. Syl., etc. Local.
Alchemilla arvensis, L., Europe, A., 3. Acc. Col. Agre., etc. Local. (Tarndale, Nelson, 4000 ft., Travers.)
Rosa micrantha, Sm., Europe, P., 3-5. Hor. Den. Via., etc.
„ *rubiginosa*, L., Europe, P., 2-3-4-5-6. Hor. Den. Via., etc.
„ *canina*, L., Europe, P., 3-6. Acc. (?) Col. Via., etc.

Rosa indica, L., China, P., 3-6. Hor. Ali. Sep. Via., etc. Local.
" *multiflora*, Thunb., China, P., 2-3-5-6. Hor. Den. Via. Sep., etc.

LYTHRARIEÆ.

Lythrum hyssopifolium, L., Europe, A., 1-2-3-4-5-6. Acc. Den. Inu. Via. In the northern hemisphere this plant is generally rare and sporadic; here it is notably a social plant, and most abundant. I have not observed that it has any tendency to become trimorphic, under altered conditions of existence.
Lythrum Grafferi, Cust., Europe, P., 2-3. Unc. Den. Syl. Pas. I have not seen this pretty plant in cultivation in the Colony.

ONAGRARIEÆ.

Œnoshera stricta, L., S. America, P., 2-3-5-6. Hor. Den. (?) Col. (?) Via. Lit.

CACTEÆ.

Opuntia vulgaris, Mill., S. America, P., *Fl. N. Z.*, ii. I have not seen this plant in a wild state.

CUCURBITACEÆ.

Cucurbita citrullus, L., A., 3-5. Hor. Ali. Via., etc. Can scarcely be said to hold its ground.
Cucurbita, sp., Pacific Islands, (?) A., 2-3-4-5-6. Hor. Ali. Via., etc. Introduced by the Maoris, as was probably the case with the preceding.

UMBELLIFERÆ.

Apium graveolens, L., Europe, B., 3. Hor. Col. Via. Local.
Petroselinum sativum, L., Europe, B., 2-3-4-6. Hor. Den., or Col. Pas. Via.
Pimpinella Saxifraga, L., Europe, P., 3. Acc. Col. Pas. Local.
Fœniculum vulgare, L., Europe, P., 2-3-4-6. Hor. Den. Via.
Daucus Carota, L., Europe, B., 2-3-6. Hor. Col. Pas., etc.
Pastinaca sativa, L., Europe, B., 2-3-4. Hor. Col. Pas., etc.
Torilis nodosa, Gært., Europe, A., (?) 3-4. Acc. Col. Pas. Via.
Scandix Pecten-Veneris, L., Europe, A., 3. Acc. Col. Agre.
Cherophyllum cerefolium, Crantz., Europe, A. *Handbook Fl. N. Z.*, p. 759. I have not seen wild specimens.

CAPRIFOLIACEÆ.

Sambucus nigra, L., Europe, P., 2-3-4. Hor. Col. Syl. Via.

RUBIACEÆ.

Galium Aparine, L., Europe, A., 3-6. Acc. Col. Via., etc.
Sherardia arvensis, L., Europe, A., (?) 1-2-3-4-5-6. Acc. Den. Pas. Via.

VATERIANEÆ.

Fedia olitoria, L., Europe, A., 3. Acc. Col. Pas.

DIPSACEÆ.

Scabiosa atropurpurea, L., India, (?) P., 1. Hor. Den. Sep. Via., etc.

COMPOSITÆ.

Erigeron canadensis, L., N. America, A., 1-2-3-4-5-6. Acc. Den. Pas. Via. Rup., etc.
Bellis perennis, L., Europe, P., 2-3-4-5-6. Acc. Den. Pas.

Conyza ambigua, D.C., Europe, A. *Handbook Fl. N. Z.*, p. 760. I have not seen wild specimens.
Eclipta erecta, L., India, A., *Handbook Fl. N. Z.*, p. 760. I have not seen wild specimens.
Siegesbeckia orientalis, L., India, A., 4. Unc. Col. Via. I am indebted to Mr. Lawson for specimens from the Great Barrier.
Woolastonia biflora, D.C., (?) India, A. *Handbook Fl. N. Z.* p. 760. I have not seen wild specimens.
Bidens pilosa, L., N. America, A., 1-2-3-4-5-6. Acc. Den. Via. Agre.
Anthemis arvensis, L., Europe, A., 3. Acc. Col. Via.
„ *nobilis*, L., Europe, P., 3-6. Hor. Col. Via., etc.
Achillea millefolium, L., Europe, P., 3-6. Acc. Agri. Den. Pas.
Matricaria inodora, L., Europe, A., 2-3-4-6. Acc. Den. Via. Agre.
„ *Chamomilla*, L., Europe, A., 2-3-4. Acc. Den. Via., etc.
Chrysanthemum Leucanthemum, L., Europe, P., 2-3-4-6. Acc. Den. Pas.
„ *segetum*, L., Europe, A., 3. Acc. Col. Agre. Local.
Senecio vulgaris, L., Europe, A., 2-3-4-5-6. Acc. Col. Agre. Via.
„ *scandens*, L., Cape of Good Hope, P., 1-2-3-4-6. Hor. Den. Sep. Via.
Osteospermum moniliferum, Willd., Cape of Good Hope, P., 3. Hor. Col. Via., etc. Local.
Cryptostemma calendulacea, Br., Cape of Good Hope, A., 3-6. Acc. Den. Pas. Via. First observed in 1863.
Centaurea nigra, L., Europe, P., 3-6. Acc. Col. Pas.
„ *solstitialis*, L., Europe, A., 3. Acc. Ali. Agre.
„ *Calcitrapa*, L., Europe, A., 3-6. Acc. Den. Via.
Carduus lanceolatus, Gært., Europe, A., (B. in Europe) 1-2-3-4-5-6. Acc. Den. Agre. Via. Commonly called "Scotch Thistle," but erroneously: that species is the *C. arvensis*, Curt., which happily has not yet been introduced.
Silybum Marianum, Gært., Europe, A., 2-3-4. Hor. Col. Pas. Via.
Lapsana communis, L., Europe, A., 3-6. Acc. Col. Via. Agre.
Arnoseris pusilla, Gært., Europe, A., *Fl. N. Z.* ii. I have not seen N. Z. specimens: can *Lapsana communis* be the plant intended?
Cichorium Intybus, L., Europe, P., 2-3-4. Hor. (?) Acc. (?) Col. Pas.
Hypochæris glabra, L., Europe, A., 3-4. Acc. Col. Rup. Pas.
„ *radicata*, L., Europe, P., 1-2-3-4-5-6. Acc. Den. Pas. Via. Major Heaphy informs me that this plant was extremely rare in the neighbourhood of Auckland in 1856–7. It is now found over the entire province, a most troublesome and abundant weed, especially on clay soils. Sometimes shown on sheep runs.
Thrincia hirta, Roth., Europe, P., 3. Acc. Den. Pas.
Apargia autumnalis, Willd., Europe, P., 3-4. Acc. Col. Pas.
Tragopogon minor, Fries., Europe, B., 3. Acc. Col. Pas.
„ *porrifolius*, L., Europe, B., 3. Unc. Col. Pas.
Helminthia echioides, Gært., Europe, A. P., 1-2-3-4-5-6. Acc. Den. Pas. Via., etc. Not unfrequently the withered stems retain sufficient vitality to produce flowers and seed two seasons.
Sonchus oleraceus, L., Europe, A., 1-2-3-4-5-6. Acc. Den. Pas., etc. *S. asper*, Hoff., the *S. oleraceus* of the Handbook, is certainly indigenous.
Sonchus arvensis, L., Europe, P., 2-3-4. Acc. Col. Agre.
Taraxacum Dens-Leonis, Desf., Europe, P., 2-3-4-6. Acc. Den. Pas., etc. The var. *palustris* is the only form indigenous to this province, and is extremely rare.
Barkhausia taraxacifolia, Thi., Europe, B., 6. Acc. Col. Agre.

Barkhausia fœtida, Mœnch., Europe, B. (P. in N. Z. ?), 6. Acc. Col. Agre.
Crepis virens, L., Europe, A. (P. in N. Z. ?), 1-2-3-4-5-6. Acc. Den. Pas. Via.
Xanthium spinosum, L., Europe, A., 2-3-6. Acc. Col. Via., etc. First observed in 1863, on Mount Eden.

STYLIDIEÆ.

Stylidium graminifolium, Swartz., Australia, P., 3. A solitary specimen was picked on clay hills near Auckland, by Col. Bolton in 1851, but the plant has not been collected since. *Handbook Fl. N. Z.*, p. 168.
Stylidium spathulatum, Br., Australia, P., *Fl. N. Z.*, ii. Stated erroneously to have been collected at Tasman's Bay.

ERICEÆ.

Epacris purpurascens, Br. *Fl. N. Z.*, ii. Considered by Dr. Hooker to have been introduced, but on imperfect information. The plant is certainly indigenous.*

PRIMULACEÆ.

Anagallis arvensis, L., Europe, A., b. *cœrulea*, 1-2-3-4-5-6. Acc. Den. Agre. Pas., etc. Var. b. near Auckland only.

APOCYNEÆ.

Vinca major, L., Europe, P., 2-3-6. Hor. Den. Sep. Via.

GENTIANEÆ.

Erythræa centaurium, Pers., Europe, A., 1-2-3-4-5-6. Hor. Den. Eri. Pas. Archdeacon Williams informs me this occurs in abundance at Poverty Bay.

BORAGINEÆ.

Cynoglossum micranthum (?), India, B. *Fl. N. Z.*, ii. I have not seen specimens of any plant in N. Z. belonging to this genus.
Echium vulgare, L., Europe, B., 6. Acc. Col. Via. I am indebted to Mr. Gillies for specimens collected on the west side of the Firth of Thames.
Lithospermum arvense, L., Europe, A., 3. Acc. Col. Agre. Via.

CONVOLVULACEÆ.

Ipomœa chrysorrhiza, Forst., Tropics, P. *Handbook Fl. N. Z.*, p. 760. I have not seen this plant in a wild state.
Ipomœa Batatus, Lam., Tropics, P., 2-3. Hor. Ali. Via., etc. Occasionally met with on abandoned native cultivations, but rarely proves permanent.

ASCLEPIADEÆ.

Asclepias nivea, L., North America, P., 3. Hor. Ali. Via.

SOLANEÆ.

Solanum nigrum, L., Europe, P. (A. in Europe), 1-2-3-4-5-6. Hor. (?) Acc. (?) Den. Agre. Via. Probably introduced by the Maoris who use the leaves and young tops as food.
Solanum tuberosum, L., South America, P., 1-2-3-4-5-6. Hor. Ali. Via., etc. Ripens seed but rarely in an uncultivated condition.
Solanum virginianum, L., N. America, P., 1-2-3-6. Hor. Ali. Via.

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* See ante, page 107, "On *Epacris purpurascens*, as a New Zealand plant."

Solanum indicum, L., India, P., 3-6. Hor. Ali. Via.
Physalis Alkekengii, L., Europe, P., 3. Hor. Ali. Via.
„ *peruviana*, L., South America, P., 1-2-3-4-5-6. Hor. Den. Via. Agre. Syl.
Capsicum annuum, L., America, A., 3. Hor. Ali. Via., etc.
Lycopersicum esculentum, Mill., S. America, A., 2-3-4. Hor. Ali. Via., etc.
Datura stramonium, L., Europe, A., 2-3-6. Hor. Ali. Agre. Via.
Nicotiana tabacum, L., America, A., 2-3-6. Hor. Ali. Agre. Via.
Lycium Barbareum, L., Barbary, P., 1-2-3-6. Hor. Col. Via.

SCROPHULARINEÆ.

Verbascum Thapsus, L., Europe, B., 3-4-6. Hor. Col. Eri. Via.
„ *phœniceum*, L. Included, on the authority of the writer, in the list of naturalized plants published in the *Handbook Fl. N. Z.*, but has not proved permanent.
Verbascum glabrum, L., Europe, B., 2-3-4-5. Hor. Den. Eri. Via.
Herpestes cuneifolia, Spr. *Handbook Fl. N. Z.*, p. 203. Included in Raoul's list of New Zealand plants, probably in error.
Veronica arvensis, L., Europe, A., 1-2-3-4-5-6. Acc. Den. Agre., etc.
„ *serpyllifolia*, L., Europe, P., 1-2-3-4-5-6. Acc. Den. Pas., etc.
„ *agrestis*, L., Europe, A., 3. Acc. Den. Agre.
„ *Buxbaumii*, Ten., Europe, A., 3-6. Acc. Den. Agre.
„ *officinalis*, L., Europe, P., *Fl. N. Z.* ii. I have not seen N. Z. specimens. Can *V. serpyllifolia* have been mistaken for it.
Veronica Anagallis, L., Europe, P. *Handbook of N. Z. Fl.*, p. 761. I have not seen N. Z. specimens either indigenous or naturalized; and in the absence of positive information am not aware of any reason for considering it introduced, except its being a common European plant.
Digitalis purpurea, L., Europe, P., 3. Hor. Den. Via. Syl. I have seen this plant in other districts, but am unable to refer to any notes respecting it.
Linaria elatine, Mill., Europe, A., 3-6. Acc. Col. Agre. Via.

VERBENACEÆ.

Verbena officinalis, L., Europe, P., 1-2-3-4-6. Acc. Den. Eri. Via.

LABIATEÆ.

Plectranthus australis, Br., Pacific Islands. *Fl. N. Z.* ii. Erroneously introduced into Raoul's Catalogue of N. Z. Plants.
Mentha aquatica, L., Europe, P., 2. Hor. Den. Pal. Local.
„ *piperita*, Sm., Europe, P., 3-6. Hor. Den. Pal.
„ *viridis*, L., Europe, P., 3-4-5-6. Hor. Den. Via. Pas.
„ *dentata*, L., Europe, P., 3-6. Hor. (?) Den. Inu. Via.
Stachys arvensis, L., Europe, A., 1-2-3-4-6. Acc. Den. Agre. Pas.
Nepetata Cataria, L., Europe, P., 4. Unc. Col. Sep. Local.
Marrubium vulgare, L., Europe, P., 2-3-6. Hor. Den. Via., etc.
Calamintha Acinos, Clairv., Europe, P., 4. Unc. Col. Pas. Local.
Prunella vulgaris, L., Europe, P., 1-2-3-4-5-6. Acc. Den. Pas. Via.

PHYTOLACCEÆ.

Phytolacca decandra, L., America. *Handbook Fl. N. Z.*, p. 761. Included in the list, by a clerical error, instead of the next species.
Phytolacca octandra, L., Mexico, P., 3-6. Unc. Den. Via. Sep. Frequently decandrous and decagynous.

PLANTAGINEÆ.

Plantago major, L., Europe, P., 1-2-3-4-5-6. Acc. Den. Via. Pas.
„ *media*, L., Europe, P., 3. Acc. Col. Pas. Via.
„ *lanceolata*, L., Europe, P., 1-2-3-4-5-6. Agri. Den. Pas. Via.

POLYGONEÆ.

Polygonum aviculare, L., Europe, A. *Handbook Fl. N. Z.*, p. 761, where it is included in the list of naturalized plants, chiefly, I presume, from its rapid diffusion in the south, coupled with the fact of its being a common European plant. In this province it is not spreading more than might be expected from the increase of cultivated land. I prefer to regard it as indigenous.

Polygonum minus, Herd., Europe, A. *Handbook Fl. N. Z.*, p. 761. Except the var. *decipiens* be intended, I have not seen this plant in the colony. That form must surely be considered indigenous.

Fagopyrum esculentum, Mœnch., Europe, A., 3-6. Agri. (?) Acc. (?) Ali. Agre., etc. May possibly become a weed of cultivated land, but at present can scarcely be considered naturalized.

Rumex conglomeratus, Murr., Europe, P., 3. Acc. Col. Inu.
viridis, Sibth., Europe, P., 1-2-3-4-5-6. Acc. Den. Syl. Sep.
obtusifolius, L., Europe, P., 1-2-3-4-5-6. Acc. Den. Via.
crispus, L., Europe, P., 2-3-5-6. Acc. Den. Agre., etc.
Acetosa, L., Europe, P., 2-3-6. Acc. Col. Pas.
Acetosella, L., Europe, P., 1-2-3-4-5-6. Acc. Den. Eri. Agre.

CHENOPODIACEÆ.

Chenopodium album, L., Europe, A., 3-6. Acc. Col. Agre.
„ *viride*, L., Europe, A., 3. Acc. Col. Agre.
„ *murale*, L., Europe, A., 2-3-5-6. Acc. Den. Via. Agre.
„ *urbicum*, L., Europe, A. *Handbook Fl. N. Z.*, p. 762. I have not seen N. Z. specimens.

Chenopodium ambrosioides, L., Europe, A. (P. ?). *Handbook Fl. N. Z.*, p. 762. It seems preferable to regard this as indigenous. As in Europe, so here, soils turned over from considerable depths frequently produce this plant in abundance, which could not be the case, at present, had it been introduced by Europeans.

AMARANTHACEÆ.

Euxolus viridis, Moq., Brazil, A., 2-6. Unc. Col. (?) Ali. (?) Via. The occurrence of this plant in the Bay of Islands or Whangarei districts, rests upon Cunningham's authority (see "Handbook," p. 233), no other botanist appears to have met with it. Observed by the writer in a solitary locality at the Thames, but on ground set apart for building purposes.

Amaranthus lividus, L., N. America, A., 3. Unc. Col. (?) Ali. (?) Via.
„ *oleraceus*, L., East Indies, A., 2-3-4. Unc. Den. Via.
„ *Blitum*, L., Europe, A., 2-3. Acc. Col. Via. Agre.
„ *retroflexus*, L., N. America, A., 2-3-4. Acc. Col. Via.
„ *caudatus*, L., East India, A., 1-3. Hor. Col. Via., etc.

EUPHORBIACEÆ.

Euphorbia Lathyris, L., Europe, P., 6. Hor. Col. Syl.
„ *Peplus*, L., Europe, A., 1-2-3-4-5-6. Acc. Den. Agre., etc.
„ *Helioscopia*, L., Europe, A., 1-2. Acc. Den. Agre. Via.

Jatropha Curcas, L., S. America, P. *Fl. N. Z.*, ii. I have not seen N. Z. specimens.

Ricinus Palma-Christi, L., East Indies, P., 2-3-6. Hor. Col. Agre. Via.
Poranthera ericifolia, Ruge., Australia, P. *Fl. N. Z.*, ii., Dr. Sinclair. I have not seen wild specimens.

URTICEÆ.

Urtica urens, L., Europe, A., 2-3. Acc. Col. Via. Local.
„ *dioica*, L., Europe, P., 3. Acc. Col. Via. Local.
Ficus Carica, L., South Europe, P., 2-3-5-6. Hor. Ali. Syl., etc.

DIOSCOREÆ.

Dioscorea alata, L., India, P., *Handbook Fl. N. Z.*, ii. I have not seen wild specimens.

MARANTEÆ.

Canna Indica, Rose, India, P., 3. Hor. Col. (?) Ali. (?) Via.

IRIDEÆ.

Sisyrinchium anceps, L., N. America, P., 6. Unc. Col. Via. I am indebted to Mr. Gillies for specimens collected near Mata-Mata.
Iris Germanica, L., Europe, P., 2-3-5-6. Hor. Den. Pas. Via.
Gladiolus byzantinus, L., Turkey, P., 6. Hor. Col. Pas. Via.
Antholyza æthiopica, Ker., Cape of Good Hope, P., 2-3-6. Hor. Col. Via.

AMARYLLIDEÆ.

Agave Americana, L., America, P., 2-3-6. Hor. Col. Via.

AROIDEÆ.

Colocasia antiquorum, Scholl., Asia, P., 2-3-4-5. Hor. Col. (?) Den. (?) Pal. Via.
Alocasia Indica, Scholl., India, P., *Handbook Fl. N. Z.*, p. 762. I have not seen N. Z. specimens.
Richardia Africana, Kunth., Egypt. etc., P., 2-3-6. Hor. Col. Pal. Via.

JUNCAGINACEÆ.

Aponogeton distachyon, L., Cape of Good Hope, P., 1-(2 ?). Hor. Den. Lac. I am indebted to Captain F. W. Hutton for my knowledge of the existence of this plant at Waimate, where it is said to have been planted by the missionaries, and is now abundant in streams, etc. Dr. Stratford showed me a plant in his garden which he believed had been sent to him from Whangarei, with the information that it was frequent in streams. I should be glad to receive more precise information respecting these localities.

LILIACEÆ.

Allium vineale, L. (?) Europe, P., 1-2-3-4-5. Hor. Den. Pas. Probably introduced by Marion, at the Bay of Islands, in 1772. (*Vide* "Thompson's Story of New Zealand," Vol. i., p. 236). In some localities it covers acres of ground, but quickly dies down. As I have not seen flowers the identification must be regarded as doubtful.
Asphodelus fistulosus, L., Europe, P., 1-3. Hor. Col. Pas. Agre, etc.
Asparagus officinalis, L., Europe, P., 2-3. Hor. Ali. Sep., etc. Occasionally solitary plants are seen, probably originating from seeds conveyed by birds: although growing vigorously they do not spread, and can only be expected to do so in strictly littoral localities, As a naturalized plant it occupies exactly the same position in which it is seen in the midland counties of England.

CYPERACEÆ.

Cyperus tenellus, L., South Africa, A., 3. Acc. (?) Den. Inu. Pas., etc. In vast abundance from Auckland to the Kaipara: one of the first spring plants collected by the writer after his arrival in the province in 1863, when it had, as now, all the appearance of a true native.

GRAMINEÆ.

Alopecurus pratensis, L., Europe, P., 2-3-5. Agri. Col. Pas.
„ *agrestis*, L., Europe, A., 3. Acc. Col. Agre. Found also in Wellington. *Handbook Fl. N. Z.*, p. 321.
Phleum pratense, L., Europe, P., 2-3-4-5-6. Agri. Den. Pas.
Phalaris canariensis, L., Europe, A., 1-2-3-4-5-6. Acc. Den. Via. Agre.
Holcus lanatus, L., Europe, P., 1-2-3-4-5-6. Acc. Den. Via., etc.
„ *mollis*, L., Europe, P., 1-2-3-4-5-6. Acc. Den. Pas. Via.
Panicum colonum, L., Australia, A. *Handbook Fl. N. Z.*, p. 324. I have not seen N. Z. specimens.
Panicum gibbosum, Br., Australia, A. *Handbook Fl. N. Z.*, p. 324. Probably included in Raoul's list of N. Z. plants, by mistake.
Panicum glaucum, L., Tropics, A. *Handbook Fl. N. Z.*, p. 324. I have not seen wild specimens.
Setaria viridis, P. de Beauv., Europe, A., 2-3. Acc. Col. Inu. Pas.
„ *italica*, P. de Beauv., Europe, A., 3-6. Acc. Den. Via. Pas. Mr. W. T. Bassett informed me that he first observed this grass at Papatoitoi, about 1863: it is now to be found for several miles by the road-sides, etc.
Aristida calycina, Br., Australia, A. *Handbook Fl. N. Z.*, p. 330. Doubtful if ever found in New Zealand.
Agrostis vulgaris, With., Europe, P., 2-3-4-6. Agri. Den. Pas. Via.
Gastridium lendigerum, Gaud., Europe, A., 2-4-6. Agri. Col. Pas. Via.
Cynodon Dactylon, L., Europe, P., 1-2-3-4-6. Agri. Den. Pas. Via.
Digitaria sanguinalis, Scop., Europe, A., 1-2-3-4-5-6. Acc. Den. Via. Agre.
„ *humifusa*, Pers., Europe, A., 3-6. Acc. Col. Via. Pas.
Eleusine indica, Gært., India, A. *Handbook Fl. N. Z.*, p. 331. "Has been gathered near Auckland." I have not seen N. Z. specimens.
Anthoxanthum odoratum, L., Europe, P., 1-2-3-4-5-6. Agri. Den. Pas. Via.
Aira caryophyllea, L., Europe, A., 3-6. Acc. Den. Eri.
Avena sativa, L., Europe, A., 1-2-3-4-6. Agri. Col. Agre., etc. In great abundance on sea cliffs in the Kaipara.
Poa annua, L., Europe, A., 1-2-3-4-5-6. Acc. Den. Pas. Via., etc.
„ *pratensis*, L., Europe, P., 2-3-4-5-6. Agri. Den. Pas., etc. The var. *angustifolia* is the more common form.
Poa trivialis, L., Europe, P., 3. Agri. Col. Pas. Inu. Too closely cropped by cattle to allow of its rapid diffusion.
Eragrostis Brownii, Kunth., Australia, P., 1-3. Acc. Den.. Eri., etc. Abundant over a large district at Keri Keri, Bay of Islands, growing amongst the low Tea-tree, and giving an abundant supply of nutritious grass, much liked by cattle and horses. Mr. H. T. Kemp informed me he first observed it in 1865, and that it was spreading with great rapidity: less common in the Auckland district.
Eragrostis eximia, Steud., Australia. *Handbook Fl. N. Z.*, p. 344. Erroneously reported to have been found in N. Z.
Briza minor, L., Europe, A., 1-2-3-4-5-6. Acc. Den. Agre., etc.
„ *maxima*, L., Europe, A., 3-6. Hor. Col. Pas. Via.
Dactylis glomerata, L., Europe, P., 1-2-3-4-5-6. Agri. Den. Pas., etc.
Cynosurus cristatus, L., Europe, P., 2-3-4-6. Agri. Col. Pas.

Festuca bromoides, L., 1-2-3-4-5-6. Acc. Den. Eri. Via.
Bromus erectus, Heids., Europe, P., 3. Acc. Col. Pas.
„ *sterilis*, L., Europe, A., 1-2-3-4-5-6. Acc. Den. Via., etc.
„ *tectorum*, L., Europe, A., 3. Acc. Ali. Via.
„ *commutatus*, Schrœd., Europe, P., 3-6. Acc. Col. Pas., etc.
„ *mollis*, Parl., Europe, A., 1-2-3-4-5-6. Agri. Den. Agre. Via., etc. Found also in Marlborough, Buchanan; Nelson, ascending to 4000 feet, Travers. *Handbook N. Z. Fl.*, p. 342.
Bromus racemous, Parl., Europe, A., 3-4-6. Acc. Col. Agre. Pas. Also found in Otago. *Handbook N. Z. Fl.*, p. 342.
Bromus arvensis, Godr., Europe, A., 3. Acc. Col. Agre.
„ *patulus*. Parl., Europe, A., 3. Acc. Ali. Agre.
Ceratochloa unioloides, Pal. de Beauv., P. in N. Z., N. America, 2-3-6. Agri. Den. Pas., etc.
Arundinaria macrosperma, Mich., N. America, P., 5. Hor. Ali. Agre., etc. Confined to abandoned Maori cultivations; probably introduced by the missionaries.
Lolium perenne, L., Europe, P., 1-2-3-4-5-6. Agri. Den. Pas., etc.
„ *italicum*, Braun., Europe, B., 2-3-4-6. Agri. Col. Agre. Pas., etc.
„ *temulentum*, L., Europe, A. var. b. *arvense*, 1-2-3-6. Acc. Col. Agre. Lit. A widely variable plant. A depauperated state, with solitary spikelets, has been collected near Auckland.
Triticum sativum, L., A., 2, etc. Agri. Ali. Agre., etc. Frequently renewed from accidental causes, but can scarcely be said to maintain its ground.
Hordeum sativum, L., A., 3, etc. Agri. Ali. Via. This is even more fugitive than the preceding.
Hordeum murinum, L., Europe, A., 2-3-4. Acc. Col. Via. Rup.
Lepturus incurvatus, Trin., Europe, A., 3. Acc. Col. Lit. Inu.
Anthistiria australis, Br., Australia, P., Auckland, Dr. Sinclair, *Handbook Fl. N. Z.*, p. 325. I have not seen N. Z. specimens.
Apluda unitica, Br., India, P., *Handbook Fl. N. Z.*, p. 325. I have not seen N. Z. specimens.
Andrapogon refractus, Br., Australia, P., *Handboak Fl. N. Z.*, p. 325. Doubtful if ever seen in New Zealand.

It has been difficult to decide whether some of the plants in the foregoing list should be assigned to the "Denizen" or "Colonist" class; and the same difficulty has been experienced, although in a smaller degree, with a few plants at present classed as "Alien." Without doubt a few years will show the necessity of removing many "Colonists" to the "Denizen" class, and possibly a small number of "Aliens" to the "Colonist" class; and the entire grouping in this paper may possibly be revised with advantage, whenever the naturalized plants of the southern provinces are worked up. As has already been indicated, I hope to return to the subject at an early opportunity, and therefore forbear from further extending a paper which has already exceeded the limits originally proposed.

I would, however, take this opportunity of earnestly pressing upon the attention of botanists in other parts of the colony, the importance of paying immediate attention to this branch of botanical study:—Dr. Hooker well remarks, "that now is the time for certifying the dates of the introduction of many plants, which, though unknown to the islands a quarter of a century ago, are already actually driving the native plants out of the country, and will before long take their places, and be regarded as the commonest native weeds in New Zealand." A few, very few years will accumulate difficulties to an extent which can only be appreciated by students of European floras, and make that

which might now be done with facility, a work which will task the critical skill of the most experienced observers.

Perhaps I may be permitted to add a word of caution :—there is some danger of attaching too great importance to the rapid spread of plants in certain localities, as evidence of their exotic origin : for example, *Gypsophila tubulosa*, and *Polygonum aviculare*, are regarded as introduced chiefly on this ground. But truly native plants as *Microlæna stipoides*, and *Danthonia semi-annularis*, have increased in an equally remarkable degree in the northern part of this province during the last four or five years, and have evinced a surprising power of adaptation to altered and altering circumstances, beyond having become plentiful in undisturbed localities where they were formerly scarce. Facts of this kind, however startling in their nature, and obscure in their origin, are of high significance and importance in their relations, and show most forcibly the impolicy of adopting sweeping conclusions, and the necessity for patient and continuous observation.

Comparative statement of the position of the species enumerated in the foregoing catalogue:

Denizens	109
Colonists	111
Aliens	31
Extinct and Erroneous . .	12
Probably Indigenous . . .	9
Position not known . .	20
Total	

III.—CHEMISTRY.

ART. XXVII.—*On the production of certain* CRYSTALLINE PHOSPHATES *and* ARSENIATES. By W. SKEY, Analyst to the Geological Survey of New Zealand.

[*Read before the Wellington Philosophical Society, February* 9, 1869.]

A GREAT many minerals occur in a natural state, which, in their chemical constitution, their crystalline form, or both combined, have not yet been artificially produced.

It seems very desirable to know, both upon chemical and geological grounds, the conditions necessary for their production, and especially in those forms which they assume in nature.

The metallic phosphates and arseniates—a group of salts which, almost without exception, are only known in the laboratory as gelatinous or pulverulent precipitates,—stand conspicuous among those native minerals, which we have hitherto been unable to obtain by artificial means in their crystalline forms.

I have recently attempted the crystallization of some of these compounds, with a certain degree of success ; and further, in the course of my experiments, I have succeeded in crystallizing some phosphates, which, hitherto, have not assumed such a crystalline form, either naturally or artificially.

The process I employ is to add a soluble phosphate, or arseniate, to the solution of a salt of the metal, the phosphate or arseniate of which, is required, in the manner hitherto adopted, but only in such limited quantity, that the mixed solution remains acid in its reaction, instead of alkaline, as occurs in the usual method of procedure. If the precipitate is long in appearing, it may occasionally be crystalline; if it comes at once it will be gelatinous, as usual, but in the course of a few hours, sometimes, however, a few days, it will be found crystallized throughout.

The essential features of this process are :—

1st. The maintenance of the precipitated metallic salt in its integrity, which is effected by having the surrounding solution feebly acid.

2nd. Allowing motion to the particles of these gelatinous precipitates, whereby they are amenable to the action of crystallizing force; this is accomplished by keeping a little of the same phosphate in a soluble state in contact with them.

In this manner I have succeeded in crystallizing the following phosphates and arseniates, which occur in this form in the natural state :—

Phosphate of Zinc,—Hopeite, $(Zn. O)_3 + PO_5 + HO_5$

Phosphate of Cadmium.

Arseniate of Zinc,—Kottigite.

Arseniate of Lime,—Pharmacolite.

The following crystallized phosphates and arseniates, produced, do not occur as such in a natural state.

Phosphate of Lime $(-(CaO)_2 + HO) + PO_5 + 3\,HO$. This has the same composition as the amorphous precipitate, produced by adding a triphosphate to chloride of calcium, and then a little ammonia, (the precipitate being air-dried); and it is isomorphous with the natural arseniate of lime above, *Pharmacolite.* It crystallizes in the form of rhombs, and is acid to test paper.

Phosphate of Chromium contains 24 eqs. of water, and has probably the same constitution as Delvauxine, or hydrous phosphate of sesquioxide of iron, the iron being replaced by chromium, its colour is the same as that of chrome-alum, the substance used as the source of the chromium.

Phosphate of Silver. Only crystallized from its solution in acetic acid.

Phosphate of Baryta and Strontia are also easily crystallized. Those salts having formulæ attached, have been analyzed.

On reviewing these salts, it will be noticed that the copper, nickel, cobalt, and iron, phosphates and arseniates, are absent. Indeed, I have not been able to crystallize any of them in this manner; although I am aware that it has been affirmed, that phosphate of nickel has been artificially crystallized. But I find that all these metallic phosphates, etc., are capable of forming double phosphates, etc., with phosphates of magnesia and ammonia. The metal may, I think, be looked upon as substituting one equivalent of magnesia in the common ammoniacal phosphate of magnesia, thus $(Met + Mg\ O + NHO)$ $—PO_5\ 12\ HO$ in place of $2\ (Mg\ O) + NH_4\ O + PO_5 + 12HO$.

I also find that phosphate of zinc forms a crystallizable compound with either phosphate of cobalt or nickel. It may be remarked here that the crystalline mineral, *Kottigite,* an impure arseniate of zinc, always contains a little of both these phosphates..

Lastly, it appears that crystalline precipitates are readily produced by contact of soluble phosphates with solutions of the metals cobalt and nickel, if a salt of ammonia is also present. These precipitates contain ammonia, in small quantity, but it appears to be as an essential element in their composition, and not a mere accidental impurity; its quantity has not yet been determined.

The inferences I would draw from these results are :—

1st. That several of the crystalline, simple, natural phosphates and

arseniates, have not been produced as such, directly; but that in the first instance *compound* phosphates or arseniates have formed. Magnesia and ammonia, singly or collectively, being the other members of the term. The magnesia and ammonia being afterwards gradually substituted by the metallic oxide. A continued supply of such metallic oxide to the compound phosphate or arseniate, would almost certainly effect this, the metallic phosphates and arseniates being more insoluble than the alkaline ones.

2nd. This property of some of the metallic phosphates, etc., of combining with phosphate of magnesia and ammonia, to form insoluble compounds, makes it very probable that several of these natural phosphates and arseniates may contain very appreciable quantities of ammonia or magnesia. At any rate, I think, with this property manifested, it would be well to examine rigorously this class of compounds, for either of these substances.

These notes are, of course, merely preliminary, there being several points of interest left undiscussed, which can only be properly represented along with the results of future investigations.

ART. XXVIII.—*On the effects of the Application of the* HOT BLAST *to Blowpipe purposes: and the proposed substitution of Heated Air for Oxygen in the production of certain thermal and illuminating effects.* Preliminary notice. By W. SKEY, Analyst to the Geological Survey of New Zealand.

[*Read before the Wellington Philosophical Society, June* 19, 1869.]

THE useful and well-known effects of the hot blast, in the process of iron smelting, has induced me to try and extend it profitably to other purposes, beyond that which prompted its application in the present instance.

My experiments, as yet, have been confined to testing the effects of substituting a hot blast, for a cold one, as hitherto used, for the production of the well-known blowpipe flame; a flame so produced will be expected to have its thermal and illuminating effects augmented, but scarcely, perhaps, to that degree which experiment has demonstrated.

I had better state, at the outset, those particulars which it is necessary to know, before relating the results.

The temperature of the blast was, approximately, 500° F., the diameter of the jet, regulating its issue, was one-thirtieth of an inch, the combustible for receiving the blast was stearine.

This flame manifested a very marked superiority over the common blowpipe flame,—substances difficult to fuse in the latter, magnitite, potash-felspar, mica, readily yielded under these circumstances; while thick glass tubes half an inch in diameter, and hard German glass tubes, were tractable to an eminent degree.

Carrying my test experiments still further, I found several substances, for the fusion of which the oxy-hydrogen flame, or some equivalent of it in heating power, is said to be indispensable, also yielded before the blowpipe flame thus urged: for instance, platinum, pipe clay, fire clay, agate, opal, flint.

Several samples of each were tried and always with the same results, it could not well be, therefore, that the fusibility of any of these substances was due to the accidental presence of foreign matter, in more than usual quantity.

The platinum was the common platinum foil, also a sample prepared especially for the purpose; the only impurity found in it was iron, as traces, communicated to it in the act of forging: possibly minute quantities of some

of the other metals, of the platinum series, might be present, but they would rather tend to increase its infusibility than otherwise.

Alumina only appeared to vitrify; while, after numerous trials with crystallized quartz, I could not succeed in fusing it to a globule; thin splinters however curled round upon themselves, like scolezite, and ultimately assumed a glazed appearance, clearly showing that the melting point was all but reached.

It appears from this that a very small amount of some foreign substances exercises a marked effect upon the fusibility of silica, agate, opal, etc., being only a little less pure than rock crystal, though so readily fusible in this flame.

Regarding the illuminating power of the flame so produced: when allowed to impinge upon a solid substance such as lime or magnesia, it was not only more intense (as would be expected), but the volume of incandescent matter was largely increased.

Before I proceed to urge the further use of hot air for combustions where high temperatures are necessary, I wish to call attention to the fact, that the temperature of the flame, which I have hitherto worked with, can be largely and economically increased, by increasing that of the blast; this can easily be done to a threefold extent.

By substituting heated hydrogen (or burnt coal gas), I have also realized all the effects just instanced, with greater rapidity and decision; but the great diffusiveness of this gas, especially when heated, has prevented me as yet carrying the experiments further.

While on the subject of heating both combustibles (at least both the substances which take part in these combustions), I cannot refrain from remarking how easily the temperature of the oxy-hydrogen flame even, could be increased in this manner—the gases would of course have to be heated prior to contact. Upon their more vigorous diffusiveness, when rarified, I should rely for that solidity of flame, so necessary where the communication of very high temperature is desired. The jets regulating the issue of the gases would have to be very fine.

Proceeding now to the next part of this subject: the result of these experiments, instanced, urge me to recommend, for trial, the substitution of heated air for oxygen, in most of those cases where this gas is now employed in conjunction with hydrogen, or other combustible matter, as a generator of heat or light: for instance,—

1. In the metallurgy of platinum, that part of it where the metal has to be fused; also in soldering platinum stills for sulphuric acid works.
2. The fusion of alumina in the manufacture of certain gems.
3. In the production of the Drummond and Bude lights.

The fusion of platinum and alumina is now effected by the oxy-hydrogen flame.

Relative to the competency of heated air to perform the part of cold oxygen in the production of such intense lights as these (the Drummond and the Bude), I think this can be demonstrated, almost to a certainty, in the following way:

Thus—the flame employed in these investigations has certainly a minimum temperature of 4596° F., since this is the fusing point of platinum, the substance most easily fused of all those I have tried, that are infusible in the common flame; doubtless tho temperature is considerably higher, but I will take these figures. On the other hand, the actual temperature of the lime, when the Drummond light is in operation, is (on the authority of Tyndal) only 2000° Cent. = 3632° F.; hence this flame has an excess of temperature over that of the incandescent lime, equal to 964° F., a pretty good margin for

loss, surely sufficient if properly economised; but as I have already shown, this excess of temperature can be largely increased.

In view of the greater controllability of the proposed substitute,—the absence of all danger in its use—its not requiring chemical preparation,—and its cheapness, compared with oxygen; upon these several points, respectively, the question should be properly tested.

Besides the substitution of oxygen urged above, the possible fusion of the purer clays, and certain silicas, etc., in a ready and economical manner, may induce the further utilization of these substances, while in experimental chemistry the facility with which such high temperatures can be attained and kept up, may lead among other things, to some cheaper way of extracting certain metals from their oxides, aluminium, for instance, from alumina or clay.

On reviewing these results, it does seem not a little singular that a difference of not more than 500° F., in the temperature of the blast, should make the difference between the fusibility and infusibility, of such substances as platina, agate, fire clay, etc., in the blowpipe flame. It will be recollected, however, that the blast has, in this case, not only taken up the heat required to raise a single volume of it to this temperature, but another portion of heat has been taken up in a latent form, as the air expanded,—consumed as it were in lifting against the atmospheric pressure; this may be represented sufficiently well for us, by assuming the temperature of the blast, kept to its normal volume, at 700° F.

This is as yet, however, but a very slight addition to produce results, which so nearly approximate to those obtainable by the oxy-hydrogen flame, seeing the latter has an estimated temperature of 14,000° to 15,000° F., while that of the present method does not much exceed 5,000° F. The gap, as far as effects is concerned, is narrowed so much, and in a manner so unexpected, by the results here given, that one is naturally prompted to enquire whether the assigned temperature of the oxy-hydrogen flame has been obtained by direct experiment, or by calculations, based upon the ascertained temperature of other flames. The temperature as calculated, indirectly, in this last way, certainly furnishes us with figures remarkably close to those just quoted.

In reference to this important point I beg to call attention to a notice, which appeared in the "Chemical News," relative to the imperfect combustion of certain gases at high temperatures.

There we learn that at moderately high temperatures (much below 10,000° F.) oxygen and hydrogen only very partially combine,—from memory, I believe, not more than to the extent of half their weight,—the remainder of the gases of course combine, as the centre of heat is left behind. Thus, although the quantity of heat evolved by their combustion is the same, being divided over a larger volume, its intensity is proportionately diminished.

This being so, it would seem to follow, that the temperature of the oxy-hydrogen flame must be very considerably lower than that hitherto ascribed to it; and therefore the possibility of substituting it in this, or in some other manner equally economical, for the several purposes here specified, appears so much the greater.

ART. XXIX.—*On the alkalinity of* CARBONATE OF LIME. By W. SKEY, Analyst to the Geological Survey of New Zealand.

[*Read before the Wellington Philosophical Society, July* 17, 1869.]

CARBONATE OF LIME is described, in chemical works, as neutral to test paper, but this scarcely agreeing with the results of observations I have had to make upon this point, in the course of other investigations, I beg to give these results, which are as follows :—

1st. Carbonate of lime, prepared by igniting pure oxalate of lime in a close crucible, at a dull-red heat, gives an intense alkaline reaction with reddened litmus paper, after moistening with distilled water, or after reignition with pure carbonate of ammonia.

2nd. Carbonate of lime prepared directly from chloride of calcium and bi-carbonate of soda, by admixture of their aqueous solutions, and washing the ensuing precipitate till all the soda was removed, gave the same reaction with test paper.

3rd. Limestone, shells (calcareous), calc-spar crystals, and arragonite, are all strongly alkaline to test paper (at least, the samples I have tried were), the powder of any of these substances, washed with distilled water for many days, does not seem to lose any of this alkalinity.

Lastly (and I think, conclusively), precipitated carbonate of lime, prepared by either of the above processes, when agitated with weak hydrochloric acid, in successive quantities, until gradually reduced to a minute proportion of its original bulk, still manifests this reaction to an eminent degree; indeed, the solution could not be rendered permanently acid till the whole of the carbonate was dissolved.

It seems impossible, under these circumstances, to attribute this reaction to the accidental presence of free magnesia or lime, sub-carbonate of lime, or alkaline carbonates, in the precipitate; this reaction may therefore, I think, fairly be attributed to the carbonate of lime.

Art. XXX.—*On the absorptive properties of* Silica; *and its direct hydration by contact with water.* By W. Skey, Analyst to the Geological Survey of New Zealand.

[*Read before the Wellington Philosophical Society, July* 17, 1869.]

In No. 157 of the "London Chemical News," I communicated the fact that silica is hydrated and dissolved by aqueous solution of ammonia. Evidence in favour of this being given in a recent number of the same Journal, together with particulars as to the amount of this solubility, I thought it desirable to ascertain whether ammonia is absolutely necessary to ensure this, the first of these reactions, the hydration of the silica, it occurred to me that water might effect it of itself;—the action of ammonia, in this instance, being confined to bringing the silica, thus hydrated, into solution.

The following experiments tend to show this assumption to be correct.

Rock-crystal, finely pulverized in an agate mortar, then agitated with water, did not completely subside, even after the lapse of some days; the water remained turbid like clay-water, and like it, is soon clarified by the addition of an acid or a neutral salt.

The effects of such additions would, I conceive, rather retard the precipitation of the silica, by increasing the gravity of the fluid, were it not that combination between the silica and the water had commenced—were it not also for an affinity of this substance for water under these conditions,—feeble, no doubt, as to intensity, but insatiable as to quantity.

There appears to be one weak point in the evidence here tendered, namely, that agate (the substance of the mortar used), is not pure silica; still, it is so nearly pure, that upon the whole it is, I think, quite safe to leave this matter out of further consideration.

In reference to other absorptive properties of silica, I find that massive quartz, rock-crystal, and silica, prepared for estimation in the usual way, take sesqui-oxide of iron from solution of its acetate, but not from the chloride.

Prepared silica, especially, manifests this property, if ignited at a low temperature; and, besides, takes oxides of chromium and copper from their acetates, and removes certain organic matters from their aqueous solutions. These reactions are more apparent in this case, because the silica is in a finely divided state, *chemically* pulverized in fact.

These reactions show silica to be a feeble mordant, and I think they have an intimate relation to what is termed the physico-mechanical absorption of soils, etc., since we thus see that one of the main constituents of rocks and soils, supposed to be at once the most inert and the most insoluble in an ordinary way, are capable of chemically absorbing certain substances to an extent proportionate to that of the surfaces exposed; such surfaces, even those of rock-crystal itself, are certain to be in a hydrous, in fact in a pulpy state, whenever water has had prolonged contact with them. It follows, therefore, if a substance, which has hitherto been held to be so inert and so unassailable, in these respects, as quartz, is thus actually affected in this manner, we may be certain that the great bulk of our soils, and our more porous rocks, have been affected by water and saline substances in a similar manner;—we may be quite certain, that the surfaces of every siliceous stone, and of every grain of siliceous sand in our soils, is hydrated, and, by so far, advanced to the possession of what is termed the physico-mechanical absorptive power for plant-food.

It only remains for me to state that the reactions here described tend to resolve the so called "*physico-mechanical* absorption of soils for plant-food," into a simply chemical one, or, at least, as much a chemical one as are any of those undisputably recognized as such.

ART. XXXI.—*On the examination of the Bark of* COPROSMA GRANDIFOLIA, *for Alkaloids.* By W. SKEY, Analyst to the Geological Survey of New Zealand.

[*Read before the Wellington Philosophical Society, July* 17, 1869.]

THE sample I tested was named by Mr. Buchanan, at the time of collecting; it has a bright yellow colour on its inner surface, is very bitter, with a slightly hot pungent flavour. It is decidedly the bitterest of any of the barks of this family, which were pointed out to me, and for this reason I made choice of it for experiment.

The following is a brief summary of the results obtained:—it shows by an easy, simple, and I think a reliable process, that alkaloids, generally, and those of the Quina group in particular, are either entirely absent, or present only in so minute a quantity, that the bark is quite worthless as a drug, on this account at least.

A decoction of 200 grammes of the pulverized bark, in weak hydrochloric acid, was slowly evaporated to a bulk of half-an-ounce, then filtered; the filtrate did not give any precipitate with the following re-agents:

Sulphocyanide of mercury.
Sulphocyanide of zinc.
Tannic acid.

These substances are capital tests for the alkaloids generally, giving dense precipitate in a very weak decoction, even, of the common Gray bark.

ART. XXXII.—*On the Extraction of the poisonous principle of the* TUTU PLANT (Coriaria ruscifolia.) By W. SKEY, Analyst to the Geological Survey of New Zealand.

[*Read before the Wellington Philosophical Society, August* 14, 1869.]

A GREAT many experiments have, from time to time, been made upon the Tutu plant, with the object of extracting the formidable poison known by sad experience to exist therein; but, as is well known, these attempts have been always unsuccessful, and have, besides, completely failed to discover anything at all definite as to the chemical or physical character of the poison.

Among these experiments is a series I made while connected with the Geological Survey Department of Otago, a notice of which appeared in the "Juror's Report for the New Zealand Exhibition of 1865," the only result, however, being to prepare the way for future enquiry, which was promised at the time.

The Tutu plant does not grow in the neighbourhood of Wellington in any quantity, hence I have been greatly delayed in fulfilling my promise, much against my will; but recently a large quantity of the seed of this plant has been kindly presented to the Survey, for this particular purpose by Mr. H. H. Travers, and upon this I at once commenced operations.

The plan I adopted, was to separate, as well as I could, all the more immediate proximate constituents of the seed (in which the poison is known to exist), and to test each likely one by itself, in its effects upon the animal economy.

First, I extracted a portion of the finely-ground seed with cold water, and another portion with weakly acidified water, and treated them separately by a new process, now much in vogue, for the separation of alkaloids (Rogers and Girwood), all the evaporations being conducted at a temperature not exceeding 90° Fah.

The residuum from these processes was very small, and gave no indications of the presence of alkaloids to the proper tests; it consisted almost wholly of gummy matters.

The result seemed to dispose of all that was soluble in water or weak acids, and, to a certain extent, impugned the correctness of the general idea that this poison is of the nature of an alkaloid.

The part of the seed insoluble in these re-agents was next examined.

Alcohol was passed through this, repeatedly, and the extract evaporated, when a large quantity of a greenish-red coloured substance discovered itself; this treated with Ether separated into two parts, one a green-coloured oil, soluble therein; the other a resinous substance quite insoluble in this menstruum.

The resinoid substance was reserved for after-examination, and the oil at once tested in regard to its effects on the animal economy.

For this purpose, I administered about five minims of it to a full-grown cat, after a twelve-hours' fast; the oil acted as an emetic in a short time, and the greater portion of it was vomited. In half-an-hour, however, the animal showed signs of uneasiness and convulsive twitches of the ears and eyes, together with a forward jerking of the head, took place; also much frothing of the mouth, culminating in a convulsive fit, in about one hour after the dose was administered. After a little while this fit passed off, only the twitches and forward jerkings continuing; but a second very severe fit, of short duration, occurred in about one hour afterwards, after which the cat gradually rallied. These symptoms agreed generally with those exhibited by cattle and sheep, when poisoned by this plant.

Although I have made but one experiment, I think it will be allowed

that the result of this has fairly proved that the poison of the seed, and so, by a very proper inference, the poison of the plant generally, since I find an oily substance throughout it, exists in this oil, if it is not the oil itself. It therefore now only remains to be ascertained whether this oil is a single proximate substance, or a mixture or compound of such, and if the latter, which is, or which are, the active ones concerned in the production of these phenomena I have described. Unfortunately I had not sufficient of the oil to allow me to test this properly, but I am in hopes of having it by next autumn, as I have been promised a large quantity of these seeds from Taranaki.

The following are the characteristics of this oil, as ascertained up to the present time.

Somewhat viscid at common temperature, but flowing freely at a little above this; colour, pale-green; reaction, acid; taste, bland; burns away readily with much flame; scarcely volatile without decomposition; soluble in ether, alcohol, chloroform, and strong acetic acid; insoluble in hydrochloric or nitric acid; also insoluble in water; does not dry when long exposed to the air.

When boiled with solutions of the caustic alkalies there is much frothing, but only a portion of the oil dissolves, even when the boiling is continued for many hours; the portion dissolved was found to be saponified. The whole of the oil is, however, soluble in a cold alcoholic solution of potash, without yielding a precipitate when admixed with water; hence it is probable that all the acid portion of the oil is really saponifiable, that which was unsaponifiable, in the first instance, being a product of the metamorphosis of a portion of the normal oil by the process employed.

When the oil is heated to the decomposing point, a substance is given off having the pungent odour of acrolein, a substance characteristic of the the presence of glycerine, or oxide of lipyle the base of common fatty bodies.

Heated with caustic alkalies, either in the wet or the dry way, there are no alkaline vapours evolved, but in the latter case an odorous oil forms, probably, œnanthylie acid.

From the reaction of this oil, here described, it evidently belongs to the series of non-drying fixed oils; in its solubility in alcohol or acetic acid, it bears a remarkable resemblance to castor oil, the only other fixed oil, which I find to be wholly soluble in acetic acid. Now castor oil, it will be remembered, is a very peculiar oil: it does not contain any of the acids of the common oils or fats, but in place of them, two very singular acids, quite peculiar, I believe, to this variety of oil; hence I conceive that the acid part of this oil of Tutu to be also quite distinct from the ordinary fatty acids; to be in all probability, peculiar to it; and to one or more of these acids I should ascribe the poisonous effects of the oil.

If further experiments should confirm the correctness of the views here stated, this case will, I conceive, become invested with an interest beyond that immediately under our notice; since it will offer another instance in which a non-nitrogenous oily principle, is proved to affect the system like a neurotic poison; this class of poisons being almost always alkaloids, or at least nitrogenous substances.

Now it will be remembered there are several poisonous plants in Europe, which have, hitherto, refused to yield any pure poisonous principle to chemical processes, but then these processes have been, as a general rule, I believe, especially for the detection of alkaloids. With this case to point, therefore, it does seem in the highest degree probable, that in some of these cases, at least, the poisonous effects may be due to a non-nitrogenous oil, not yet isolated or examined. In view of this I have recommended the subject for examination

to a friend of mine residing in England, so that I expect in a few months to hear something more of this, or else to have selections of seeds, etc., from the plants I have named in my letter, so that I can enquire into this subject myself.*

With regard to antidotes for administration to animals, etc., poisoned with the Tutu plant, I should be inclined to think that in addition to emetics and purgatives, very dilute acids would be beneficial, since by preventing saponification of the oil, they would tend to keep it insoluble, and therefore inert.

As being somewhat related to the subject, I may state that the seed of the Karaka tree (*Corynocarpus lævigata*), which is also of a poisonous nature, has refused, in a similar manner, to yield any alkaloid to my processes, but it gives up an oil to alcohol, which resembles the above in some of its reactions. It seems to exercise a specific effect upon the animal economy, when administered in small doses, inducing at first, great uneasiness, and afterwards, restless, unwilling sleep, with sudden starting; unfortunately I had not sufficient of it to get any decisive results.

This oil is also soluble in alcohol, acetic acid, ether, and in hydrochloric acid.

It is very bitter, and feebly soluble in water.

In one important respect it differs from the oil of Tutu; it evolves ammonia when boiled with potash, thus, in regard to its composition, allying itself to the alkaloids, though in its reactions apparently distinct.

ART. XXXIII.—*On the Fusibility of* PLATINUM *in the Blowpipe Flame.*

By W. SKEY, Analyst to the Geological Survey of New Zealand.

[*Read before the Wellington Philosophical Society, November* 13, 1869.]

THE metal platinum has hitherto been supposed to be infusible, except at a temperature that is so high, as to be incapable of being produced by the common blowpipe; at least I have carefully searched for any statements to the contrary without success.

When I was lately engaged in studying the effects of the hot-blast blowpipe flame, the results of which investigation have already been communicated to the society (See p. 148), I found it necessary to test, with accuracy, the degree of fusibility of platina; and discovered that if the loss of heat from the flame, by conduction, was guarded against, platinum can be fused with an ordinary blowpipe blast through a candle flame. The method adopted was to substitute, for the metallic nozzle generally employed, a tube of clay or glass, either of which is a feeble conductor of heat, as compared with metals.

By this means fine platinum points were fused in an unmistakable manner, to beads. The blast was that ordinarily used in the laboratory by the use of the hydrostatic blowpipe, the flame being that of a stearine candle.

As it might be urged that, perhaps, the platina I treated, might contain an admixture of more fusible metal, and that its melting point might thus be reduced, I prepared some of the platina for special trial, which was absolutely free from such fusible metals.

As the fusing point of platinum has been ascertained to be 4593° Fah., we must, from the above experiment, conclude, that if proper precautions

* Since this paper was read, I learn from the "London Chemical News" for August 6, 1869, that M. Van Ankum has discovered the poisonous principle of the *Cicuta virosa* to be an essential oil, of formula, $C_{10}. H_8$. but "could not find any alkaloid in this plant at all." This was one of the plants especially selected for examination in the communication alluded to.

are taken to prevent loss of heat by conduction, this high temperature can be produced by the ordinary blowpipe operating upon flames of this description.

ART. XXXIV.—*On the Application of* IODINE *and* BROMINE, *for the detection of Gold when in minute quantities.* By W. SKEY, Analyst to the Geological Survey of New Zealand.

[*Read before the Wellington Philosophical Society, November* 13, 1869.]

THE large number of non-auriferous, or but slightly auriferous, specimens of quartz and pyritous rocks, which have lately been submitted here for examination for gold, has rendered it very desirable that some quicker, less laborious, and, if possible, more exhaustive, method of analysis, than the current one (that by amalgamation), should be employed.

In recognition of this I have frequently been urged by the Director of this Department to attempt some other process, and after several preliminary experiments I turned my attention, especially, to the use of iodine or bromine for this object.

Both of these substances differ from chlorine especially in their relatively feebler affinities for hydrogen, so there would be the less to fear, that from the generation of hydra-acids, any great preponderance of other matters would be dissolved along with the gold we wish to separate from the sample under examination.

Iodine, indeed, has already been used with advantage in the analysis of certain meteorites, for the separation of the iron and nickel existing therein in a metallic state; these it combines with, leaving the associated silicates, iron-oxides and sulphides intact.

It was this comportment of iodine with other substances, that determined me to the trial of both it and bromine for the purpose named.

The results of my experiments certainly show that either of these agents may be safely and advantageously employed for the separation of gold from its matrices.

The following are the particulars of a few of these experiments, which besides their present use, will, I think, be useful in showing what is, approximately, the smallest quantity of gold that can be positively separated and identified, by a certain course of analysis operating upon a limited quantity. The first time, I believe, anything of this kind has been attempted.

1st. 2 grammes of roasted "buddle headings" from a quartz mine at the Thames, known from previous analysis to contain gold at the rate of one ounce, or so, to the ton, was well shaken for a little while with its volume of alcoholic solution of iodine (tincture of iodine, of chemists), then allowed to subside. A piece of Swedish filter-paper was then saturated with the clear supernatant liquid, and afterwards burned to an ash; the ash, in the place of being white, as it would be if pure, was coloured purple; the colouring matter was quickly removed by bromine—a clear indication of the presence of gold. The time occupied by the whole process was twenty minutes.

2nd. 1 gramme of the same "buddle headings," mixed with such a quantity of soil as to reduce the proportion of gold present to 2 dwts. per ton, was allowed contact with its volume of the tincture for two hours, with occasional stirring; a piece of filter-paper was then saturated with the tincture, and dried, five times consecutively, and finally burnt off as before; in this case, also, the colour of the residual ash was purple, and it gave the reaction of gold.

3rd. 32 grammes of siliceous hematite, finely-pounded, was thoroughly mixed with precipitated gold to the amount of 2 dwts. per ton; then ignited, and

treated with bromine water. After two hours the solution was filtered, and evaporated to a bulk of 20 minims; this gave a good reaction of gold to the "chloride of tin" test.

4th. 100 grammes of the hematite, with precipitated gold at the rate of ½ dwt. per ton, treated as before, but this time well washed, at the expiration of the two hours, and the washings evaporated along with the first filtrate, gave a fainter, but still decided, reaction of gold to the same test.

5th. Iodine, as tincture, substituted for bromine in experiments 3 and 4, gave similar results; the only variation made was, that as a precautionary measure allowing for its feebler, or rather slower, action, I gave contact for twelve hours.

To compare the results of the common amalgamating process with the foregoing, I have made some careful experiments; and I find that it is not certain, with the same expenditure of labour, to get reliable indications of gold, when present in less quantity than 2 dwts. per ton, operating upon about 100 grammes of material, which is about the quantity I usually take.

In summing up the results of these experiments, it appears then, that for qualitative examinations for gold, or for quantitative determinations in certain cases, iodine and bromine are each superior to mercury. It also appears that a proportion of gold equal to ½ dwt. per ton, upon a bulk of 100 grammes (about 4 ozs) of ferruginous matters, can be easily and rapidly detected.

Of course, by operating upon larger quantities, gold could be discovered by this process, were it present in far less quantities, but this is sufficiently near for the majority of cases.

These processes are especially adapted for the separation of gold from sulphides, as the preliminary roasting is extremely favourable to them, not so much chemically as mechanically, I think; the loss in the substitution of oxygen for sulphur, amounting to 25 per cent., by weight, while the volume remains constant (or nearly so); hence there is a corresponding porosity in the product, by which it is certain every atom of it is thrown open to contact with the solution of these agents.

This mechanical accessibility obviously cannot be taken advantage of by mercury.

With sulphides these processes are practically exhaustive, while, at the same time, the simultaneous extraction of other matters is avoided, or, at any rate, is so trifling, that the proper tests for gold can be safely applied directly to the concentrated solution.

Regarding the choice between iodine and bromine, I would prefer the former, when mere traces of gold are supposed to be present; or if the ore is in a finely divided state, as is generally the case when the matrix is iron pyrites.

In the roasting of such pyrites it is necessary to raise the temperature towards the end to a full-red heat, in order to decompose the ferruginous sulphates, since if these remained much iron would get into the solution.

In the case of much carbonate of lime being present, it is proper to gently reignite the roasted mineral, etc., with carbonate of ammonia, or much lime might get into the iodine or bromine solution.

On the other hand a very high temperature is to be avoided, for, from my own experience, I find a considerable quantity of fine gold can escape detection in this way, by the partial vitrification of the more fusible of the silicates.

The identification of gold by the combustion of its salts with filter-paper, as suggested in this paper, seems to promise a rapid method of estimating it, comparatively, by the aid of a series of prepared test-papers, representing gold in different degrees of dilution.

IV.—GEOLOGY.

Art. XXXV.—*Remarks on the Coast Line between Kai Iwi and Waitotara, on the West Coast of the Province of Wellington.* By R. Pharazyn, F.R.G.S.

(With Illustrations.)

[*Read before the Wellington Philosophical Society, June* 19, 1869.]

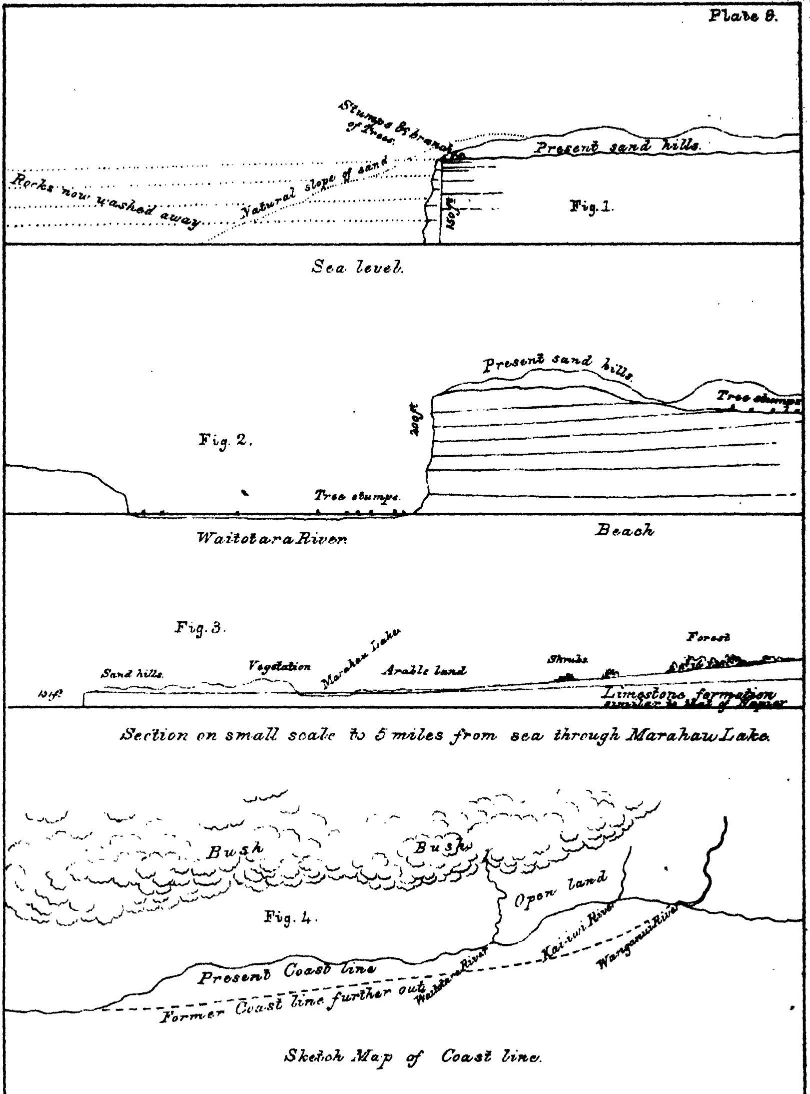
Any one accustomed to the scenery of the East Coast, must be at once struck with the contrast presented to it by that of the West. The former is rugged in the extreme, and, except in a few places, the flats, adjoining the sea beach, appear to have been formed from the slips which take place so frequently from the neighbouring hills, having, as it were, *reclaimed* the land faster than the waves could wash it away. The scenery on the West Coast is comparatively soft and undulating, this latter character being more marked as we approach Mount Egmont, whose volcanic rocks give a new feature to the landscape. The general impression produced, is, that this country has been formed by the gradual and quiet upheaval of a vast mass of marine deposits, and that there is no such incessant struggle between land and sea going on, on the West Coast, as there is on the East. But such considerations, though sufficient for the purposes of art, either pictorial or descriptive, which deal rather with effects than causes, require to be supplemented by more exact observation to meet the requirements of science. In nature, the forces which are quietest in their operation, are often the most powerful, and in geology, the question is not so much how great is the force, as how long has it operated.

I think I shall be able to adduce some facts, which go to prove that the northern portion of the West Coast has been encroached upon by the ocean, to a very considerable extent, and at a rate which is remarkably rapid, geologically speaking.

Immediately to the north of Wanganui, the margin of the coast consists of ranges of sand-hills, which are remarkable from the fact, that instead of falling away gradually to the sea beach, they terminate in cliffs which present a bold face to the sea. Between the sand-hills and the tertiary rocks, of which these cliffs consist, are the well-defined remains of an ancient forest. These remains are particularly conspicuous along the line of cliffs between the Kai Iwi and Waitotara rivers. In places they appear on the exact line of junction between the sand and the older rocks, but in general they seem to be about four feet below this level. Probably a careful investigation would show that more than one forest has grown upon the same spot, and that each has been buried at a different epoch, apparently owing to changes of level in the land, as, in places, there appear to be beds of marine shells above the *lignite*, into which much of the wood has been converted. In addition to this is the curious fact, that the bed of the Waitotara river itself is thickly studded with the stumps of trees, at a level of about 150 feet lower than those above mentioned. We have then the following facts before us.

1. Drift sand extending inland, to a distance of from one to four miles from the edge of the cliffs, and thus lying at an elevation of from 120 to 200 feet above the present sea beach.

2. The remains of one or more forests buried beneath the sand-hills, and



IDEAL SECTIONS

between

Kai-iwi and Waitotara Rivers

To accompany Paper by R. Pharazyn.

R. Pharazyn del. J.B. lith.

Printed at the Gen. Govt. Lith. Press

in the strata in which these rest, and the remains of the same or other forests at a much lower level, namely, in the bed of the Waitotara river itself.

Clearly then, here is evidence either of a very remarkable rise in the land, or of the considerable and rapid action of the waves upon it.

On first looking at the sand-hills, in question, it seems as if the whole mass had been lifted bodily upwards from the bed of the ocean. So fresh is the appearance of the sand, that it is difficult to believe that it has not been lately covered by the tide. However, this supposition is a highly improbable one, when the generally horizontal and unbroken nature of the stratification of the underlying rocks is considered, dipping, as they do, at a very small angle towards the sea, and presenting no appearance of having been disturbed since the accumulation of sand upon them.

The probability is, then, that the *present* cliffs have been formed since the great Tertiary system, which underlies all the more recent formations in this province, and in that of Hawke's Bay (being apparently identical, as to fossil contents, on both sides of the island), attained its present elevation.

Evidently, then, at one time, the surface of the rocks, in question, sloped gradually to the beach, and became covered with sand-hills (similar, in all respects to those between Paikakariki and Rangitikei), and presented no abrupt termination towards the sea.

Rocks at some depth below the surface of the water are protected from the action of the waves, but no sooner do they approach the surface, than they are exposed to the incessant cutting and grinding action of moving water. Hence it is easy to imagine that the ordinary action of the tide, apart from that of ocean currents, (though I believe these have a considerable effect on our coasts), was sufficient to wash away so much of the newly-formed land, as to give rise to the rather singular phenomenon of sand-hills terminating in high cliffs. The present coast line is, in short, a section of that which formerly existed, and apparently at no remote period.

That this period was not very remote is, I think, proved by the fact, that, at any rate, *some* of the trees, of which the stumps, and in some places the trunks, are visible, have not lost the appearance of wood, and though others have become changed into lignite, I have seen none which could be classed as Brown coal. I may mention, incidentally, that the lignite in question is so plentiful that I was informed, when lately in the Waitotara district, that it had been used as fuel at Mr. O'Hanlon's hotel, near the Kai Iwi. It is evident that the trees, I refer to, must have been growing before the sand covered the soil, and the probability is that the sand was drifted by the wind over and amongst the more recent ones. Indeed the remains of an old pa were visible till lately upon a place called Popoia, near the Okehu stream. This, though half a mile from the sea, is now nothing but a vast sand-hill. Hence, it follows, that the sea must have made such inroads upon the part of the coast in question, as not only to have washed away a considerable belt of sand-hills, but to have cut into the fertile land where a forest formerly grew, and it is not improbable, that this formed part of that forest, which middle-aged Maoris say they have heard their fathers speak of, as having covered the present fern and grass lands within their own recollection. For the comfort of land owners, I may mention that the further drifting of the sand has been prevented by the growth of vegetation, and by the formation of a high fern-covered ridge, which forms, as it were, a rampart between the sand-hills and the arable land; though while the sea will still gradually eat into the land, it will do so at a continually decreasing rate, the lower rocks being much harder than the upper, and consisting of an indurated blue clay.

The part of the coast which I have attempted to describe is well worthy the attention of a skilled geologist, and a careful examination of it, noting the

dip of the strata, and carefully examining the buried trees, would, I think, put us in possession of some very valuable data for determining the era and the rate of important geological changes. I lay on the table some rough diagrams, in explanation of such parts of my paper as may appear obscure to those who have not seen the part of the country it relates to. (See Pl. IX.)

Art. XXXVI.—*On* Alluvial Gold *in the Province of Wellington.* By J. C. Crawford, F.G.S.

[*Read before the Wellington Philosophical Society, July* 17, 1869.]

Having visited the operations at present going on in the upper part of the valley of the Kaiwarra stream, I find in that narrow valley, a greater quantity of gold washed out than could have been reasonably expected from the limited area from which it must have been derived.

Taking the actual fact of the presence of gold, in appreciable quantities, in this small valley, into consideration, I am inclined to revert to an opinion, which I long ago expressed, and which is as follows: that considering the very high angle of inclination of the main chain of the island, consisting, in this part, of the ranges of Tararua and Rimutaka, with all the subsidiary ranges, that the tendency of the denudation of the valleys, would be to wash out gold, or other minerals, which might be thereby released, beyond the boundaries of the hills, and deposit them in the valleys to the east and west of the chain.

If, on the east side, we consider the wearing away which has scooped out the valleys of the Tauherenikau, the Waiohine, the Waingawa, the Waipoua, and the Ruamahunga, we may reasonably expect, supposing the rocks are to any extent auriferous, and the fall and force of water are sufficient, that gold must have been carried out and deposited somewhere in the Wairarapa valley.

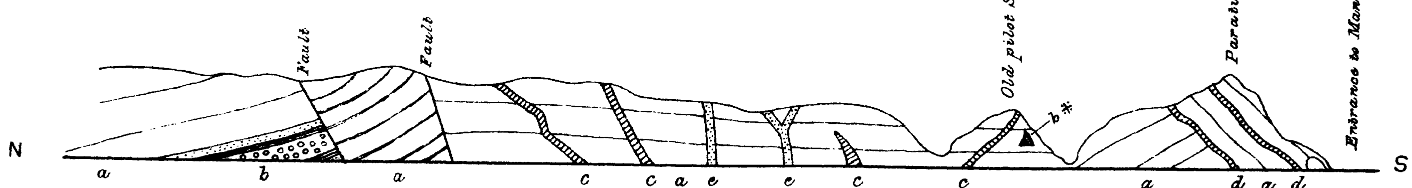
On the West Coast, in a similar way, from the valleys of the Wainui, the Waikanae, the Otaki, the Manawatu, the Rangitikei, gold may have been deposited in the trough between the main ranges and the line of Kapiti and Mana.

I put this statement theoretically: how to prove the theory to be fact, is the point to be decided. If we attempt to sink to any depth, on either side of the range, we shall probably soon require powerful pumping apparatus, and of necessity considerable capital would be required. It is possible that tentative explorations may be made, at the least difficult points, which, without going to much expense, may either lead to further trial, or to the abandonment of the idea.

Supposing the land to have formerly stood at a higher level (at a comparatively recent period), there is a possibility that the Lower Hutt Valley, and even the bottom of this harbour, may have undergone the conditions necessary for the concentration of alluvial gold.

My reasons for advancing the above theory are, the extremely steep incline of the chain on both sides, and the rapid fall of the rivers, the great general force of their currents, and the frequency of heavy floods, combined with the proved fact that gold is found, more or less, distributed within these ranges.

It is possible that the above remarks may be found applicable to the valleys of the Wakamarina and the Pelorus, in the Province of Marlborough.



Section along the Coast North of Manakau Harbour

a. Volcanic agglomerate.
b. Upper part of Waitemata series.
b* Block of Waitemata series. enclosed in agglomerate.
c. Dykes.
d. Lava streams.
e. Fissures filled with Tufa.

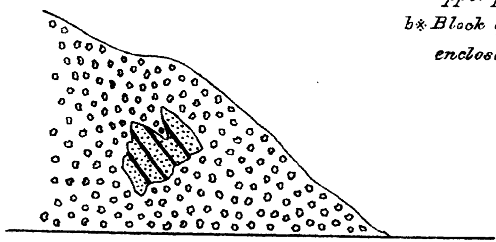


Fig. 1.
Block of Waitemata series enclosed in agglomerate.

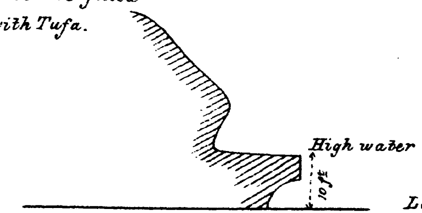


Fig. 11
Section of cliff at Paratutai.

To accompany Paper by F W. Hutton on the Geology of the North Head of Manakau Hr.

F. W. Hutton del. J.B. lith.
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ART. XXXVII.—*On the Geology of the North Head of Manukau Harbour.* By Captain F. W. HUTTON, F.G.S.

(With Illustrations.)

[*Read before the Auckland Institute, August* 16, 1869.]

THE cliffs, north of Manukau Harbour, are composed of a coarse volcanic agglomerate of various kinds of dolerite, trachyte, and rhyolite, the trachytic rocks, however, being much the most numerous. This agglomerate is generally horizontal, but at Paratutai—the rock that forms the north head of the harbour—it is seen to dip strongly to the north, and on its upturned edge rests a thin bed of vescicular doleritic lava, covered, conformably, with beds of agglomerate, to which succeeds another lava stream, also covered by agglomerate. The conformability of these doleritic rocks with the rest of the formation, together with their vescicular character, makes me class them as lava streams, instead of dykes. Proceeding northwards along the coast, several dykes of doleritic-trachyte, very similar to the lava streams already mentioned, but more compact, are seen, cutting through the agglomerate. The second of these, or the one first seen after passing the valley that divides the hill, on which the old pilot station was placed, from the rest of the cliffs, is about six feet thick at the base, and dips 80° S.E., but rapidly thins out upwards, and comes to an end less than two-thirds of the way up the cliff, showing that it has been injected from below, but had never reached the surface. Besides these true dykes there are also other reefs of rock which at first sight look like dykes, but, on a closer examination, are seen to be fissures filled up with fine-grained tufa, of the same composition as the matrix of the surrounding agglomerate. These fissures were perhaps caused by earthquakes at the time when the volcanic forces were in activity, and may help us to understand the original formation of some of the lodes at the Thames.

Proceeding further northwards, at a distance of about a mile and a half from Paratutai, we find that the lower part of the formation has been thrown up by a fault, and is seen to rest upon beds of fine-grained tufa, tufaceous sandstone, and sandstone, which, no doubt, belong to the upper part of the Waitemata series; for similar rocks occur at Puponga, as described by Dr. Hochstetter.

In the hill, under the old pilot station, a large angular mass of fine-grained tufaceous sandstone, interstratified with beds of shale, is seen, enclosed in the agglomerate. (Pl. IXa. Fig. I.) This mass is about twenty-five by fifty feet, and probably weighs not less than 2000 tons; it belongs to the underlying Waitemata beds, and must have been thrown up by a volcano. That this volcano must have existed in the close neighbourhood, is proved by the large size of the block, as well as by the lava streams at Paratutai, although no trace of it can be now recognised; and the fact that the block, although composed of fragile materials, was not shattered in pieces, proves that it was ejected under water. On the eastern, or inner, side of Paratutai the cliff is being undermined and worn away at low-water mark (Fig. II.), while at high-water mark, or a little above it, another, and older, undermining of the sea can be observed, forming a terrace, the difference of height between the two being about ten feet, showing that the land has here risen that distance since the higher one was formed. This closely corresponds to the height of the raised beach at the Thames, on which Shortland and Grahamstown are built. On the outer, or west, side of Paratutai, a similar terracing exists, as can be seen in the Rev. J. Kinder's photograph; but I was not able to measure it, and so am unable to say whether the two are at equal heights.

ART. XXXVIII.—*Description of* LAVA CAVES *at the "Three Kings," near Auckland.* By JAMES STEWART, C.E., Assoc. Inst. C.E.

(With Illustrations.)

[*Read before the Auckland Institute, September* 20, 1869.]

IT is well known that the various lava beds, near Auckland, are cavernous; caves are found of various dimensions, both in the older, and more recent lava streams, although in the former, the surface soil, washed in by floods, has partly, or wholly, filled many of them up.

Many of these known caves are of considerable size, but by far the most extensive in the district, are those, the subject of this paper, situated in the great scoria bed lying to the north-west of the hills called the "Three Kings."

Some months ago, when a number of the members of this Institute met at these caves, for their exploration, it was seen that they presented some points of interest, and in their relative situation, a little intricacy. As these could not be investigated by a cursory examination, and as it was possible that the result might prove of some value, otherwise than by satisfying mere curiosity, I was induced, in conjunction with Mr. Kirk, to undertake a survey as much in detail as circumstances would permit. The result has shown the relative positions of the caves in this group to be not a little curious, as they branch off from, and underlie each other, to some extent. The survey occupied parts of two days, in all about ten hours. Bearings were taken underground, and marked out on the surface, and regular courses of levels were then run above and below ground, the sectional dimensions of the caves being roughly noted at numerous places. The accompanying plans and sections delineate the positions and levels; I have endeavoured to make the plan as distinct as possible, without the use of colour. (See Pl. X.)

The number of distinct caves in this group, at present explored, is four. They form two sets, of two each. The two pairs have a remarkable resemblance to each other, in some distinctive features. The main pair is marked as the *north-western*, and the other as the *south* caves. In both cases, the branches return backwards, at low levels, and they just escape communication with each other. The main cave is generally straight, but of very irregular section, the roof has fallen in many places, and encumbered the floor with large blocks; at one place, near the mouth, it has broken through to the surface; it is clear that at this part the original thickness was not much over a foot. The main branch-cave is, for a great part of its length, in its original state, very little stone having fallen from the roof. At the extreme end, however, some has fallen, and much soil has been washed in.

In section this cave is extremely irregular, but in most places very interesting, from the original form having been preserved, and affording, to my mind, convincing evidence as to the cause of formation. This branch underlies the main cave in a singular manner, having a thickness of rock, between, of eight or nine feet. Both caves have several small branches or chambers. The length of the main cave of this pair is 351 feet, and of the branch, from its entrance, 209 feet. The widths vary from thirty feet to six feet, and the height from seventeen feet to less than four feet. The south cave is much fallen in, and was not minutely measured. It may have been about 200 feet long, originally, but only about ninety feet (in three divisions) are still complete. At its present most northerly entrance, the branch returns at a low level, and is 112 feet long. This branch is by far the most perfect of the caves, having, excepting near its entrance, a regular and natural floor, and terminating in a fine chamber with a domed roof.

The caves seem to be all well ventilated, the air, though extremely

humid, is quite fresh, perceptible currents of air are at all times existing in the more contracted passages, and during our last visit, when a strong breeze was blowing outside, the draughts in these places were so strong that candles could not be used without shelter. This was especially observable in the contracted parts of the north-western cave and branch, in which the current was flowing *inwards*, in both cases, but in directions *diametrically opposite*; while in the branch of the southern pair, the current was *outwards*, but only near its outer extremity, being evidently fed by the other branch, which slightly overlaps it about forty feet from its entrance. No visible communication however was observed. The positions and directions of those strong air-currents are marked on the plan by arrows.

Regarding the origin of these caves, it seems quite evident that the molten lava has found some outlet after the surface has solidified. Some very interesting traces of this process are visible, especially in the two branches. The floors are covered with curved corrugations, expressive of solidifying while in a state of slow motion, and in some cases the walls seem to have settled down a little, and squeezed the semi-plastic floor into long ridges and furrows. It seems probable that the whole group was formed from one molten stream, and not at different times from different levels. The upper caves, most likely, were formed first, and, after the floor had become firm, the still-fluid lava below seems to have found some passage downwards, somewhere near the abrupt descent or precipice in the main cave, thus forming the branch. On the face of this precipice, evidence can be traced of the descent of a portion of lava while in an almost solid state. Indeed, at this particular place, everything points to the probability of the lava having found its way into the hollows of some older lava stream. The occurrence of regular chambers, and minor branches, may be explained in the same manner, as the hotter and more fluid lava, collecting in pools, would be tapped and drained away. The roof, where in its original state, is also very suggestive of the above theory. It has all the appearance of some plastic material *pulled* asunder, having solidified in irregular guttæ.

The percolation of water has, in some places, precipitated, on the surface of the roof, a mineral, generally white, but having, in several places, a red or green tinge. I am not aware of the nature of this mineral, but it is probable that lime, which enters in small quantities into the composition of our scoria, is the chief ingredient.

Such is a brief and imperfect description of an interesting part of the Auckland scoria beds. The survey was attended with many difficulties, owing to the general roughness, and contracted dimensions of some of the passages, and the use of the level and staff in these, was anything but easy. On these grounds it is hoped that all imperfections will be excused.

Art. XXXIX.—*On the Wanganui Beds (Upper Tertiary)*. By J. Buchanan, of the Geological Survey of New Zealand.

[*Read before the Wellington Philosophical Society, September* 18, 1869.]

The following notes give the results of a comparison of the fossil shells from the Upper Tertiary stata of New Zealand, which are in the Colonial Museum, with the fossils obtained by the author, in that portion of the formation locally known as the "Wanganui series":—

Wanganui Beds (Upper Tertiary).

The information, respecting the latter series, is founded on personal examination of the cliffs of the Wanganui river, near the township, and

continued six miles on No. 2 road-line, in the direction of Wangaehu, and six miles on No. 3 road-line, up the river; also, as far north as Patea for forty miles along the sea coast, at various points between the Kai Iwi and Waitotara rivers, and between the Whenuakura and Patea rivers.

Over the area thus surveyed, the beds are uniformly the same, so that it is unnecessary to protract a section of each particular locality.

In some places they are slightly disturbed—as for instance opposite the town of Wanganui—but, on the whole, they strike in North and South line, with a dip of 10° to 15° to the East; the blue clay stratum which I shall describe, keeping, in general, parallel with the drainage level of the country.

The formation consists of an upper sandy, and lower clay stratum, and separated by a deposit of sand of varying thickness, being at least twelve feet in Shakespere cliff, at Wanganui, the whole covered by a heavy deposit of sands and gravels, containing a cemented gravel bed also of variable thickness, the material from which is in common use for the construction of roads throughout the district.

Along the sea coast the blue clay rises to a height of from one to forty feet above the sea level. A few shells appear to be confined to this deposit, such as Murex* No. 2, Pecten No. 2, and Mytilus No. 2. A few others decrease upwards in the series such as Ancillaria, Murex No. 1, Fusus No. 2, Pecten No. 1, and Ostrea No. 2. Again, a few shells, poorly represented in the blue clay, become very numerous in the upper bed, such as Lucina No. 2, Rotella, Waldheimia, and *Imperator imperialis*.

The upper bed of the series has generally an open sandy matrix, varying in thickness from four feet at Shakespere cliff, to over a hundred feet at the lower cliffs below Putiki pa; the blue clay, or lower bed, scarcely showing there above the river level.

In this upper bed the following species occur for the first time, in addition to those mentioned as common to both formations:

Ostrea ingens,	*Cardium* No. 2,	Tapes,
Ostrea No. 3,	*Pecten* No. 7,	Tellina,
Pectunculus No. 1,	Mactra No. 1,	*Pileopsis*,
Pectunculus No. 3,	Mactra No. 2,	Triton,
Pecten No. 3,	Donax,	Myadora.

(Extinct forms are in italics.)

There is every probability that, in addition to the above two beds, an older stratum exists, more inland, characterized by the presence of Cucullæa, and if the blue clay of the Patea river should prove to belong to this lower bed, the proportion of extinct species in the Wanganui beds would be considerably diminished.

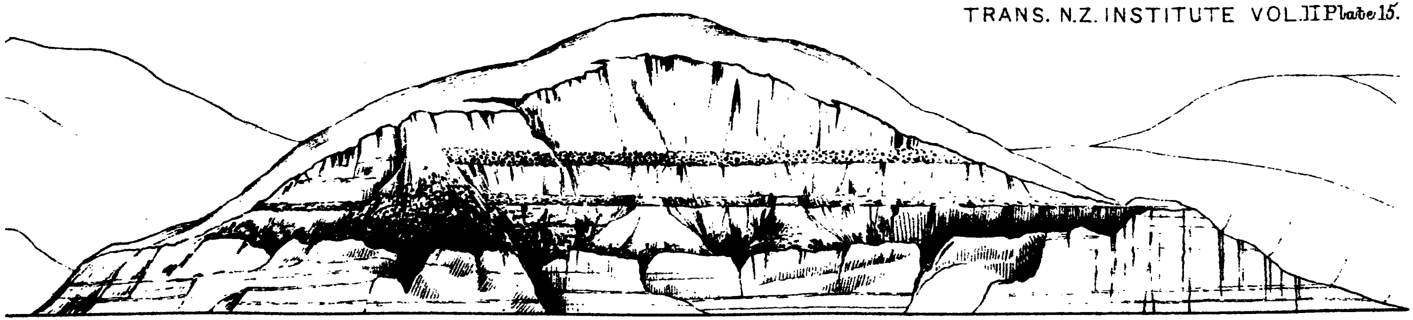
Napier Beds (Upper Tertiary).

The fossils collected at Napier are too few to determine the relative position of the Limestone formation there; but there is no doubt that several of them are identical with those of the Upper Wanganui beds, and probably belong to the same period.

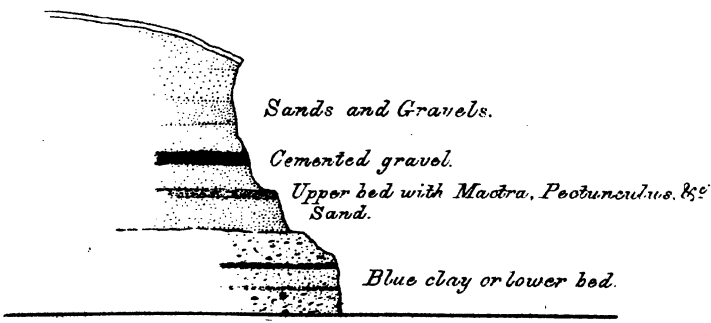
Blue Clay-marl. Kanierei River, Westland.

Of the fifteen species collected at Hokitiki, every one of them are common at Wanganui, so that it may be inferred that they belong to the same period.

* Instead of attempting to give scientific names, the numbers by which each specimen is distinguished in the Museum, is employed.—Ed.



SHAKESPERE CLIFF WANGANUI.



Section of Shakespere Cliff.

To accompany Paper by
J. Buchanan on the
UPPER TERTIARY FOSSILS OF
WANGANUI &c.

J. Buchanan del. & lith.

Printed at the Gen. Gov. Lith. Press, by J. Martin.

Kawau Island Beds.

The Kawau Island deposits contain only extinct species, and have been erroneously grouped with the newer-tertiary formation, by Hochstetter, from the species having been mixed with more modern forms from a littoral deposit at Cape Rodney.

A list of the Cape Rodney shells is given separately; all of them being extinct species.

Awatere and Motanau Beds (Upper Tertiary).

The Awatere and Motanau clays are undoubtedly of the same age, and it is very probable, when further examined over the whole area, will be naturally grouped in three subdivisions. At Motanau three beds can be distinctly recognized: first, an upper sandy bed, containing the most common shells of the adjacent coasts; second, a middle blue clay bed, containing probably fifty species, nine-tenths of which are identical with those of the blue clay at Wanganui; these upper and middle beds lie conformable, and have, evidently, like those at Wanganui, been accumulated on their breeding grounds, on quiet sea bottoms. Not so the third, or lower, blue clay bed, found inland near its outcrop. It exhibits masses of concreted broken shells, the result of wave action on an ancient sea beach. The proportion of extinct species in this series is very small, and those chiefly miocene fossils, of the lower bed, such as Cucullæa.

SUMMARY.

By a comparision of the fossils collected in the different districts, with those of Wanganui taken as a standard—as being the most complete—the evidence is conclusive of the sameness of the whole, with the exception of the Kawau beds, as a reference to the columns will show.

The formation must be divided into three groups: an upper, a middle, and a lower; nearly every genus of the upper and middle beds still existing on the adjacent coasts.

Napier.

Ostrea—2 sp., Mytilus, Pecten—3 sp., Crepidula, Calyptræa, Venus, Pectunculus. Total, 10 sp.: recent 7, extinct 3.

Cape Rodney.

Haliotis, Cardium, Scalaria, Fusus—2 sp., Turritella, Teredo, Pectunculus, Pecten—2 sp., Rhynchonella, Turbo, Ostrea. Total, 14 sp.: recent 13, extinct 1.

Kawau.

Ostrea, Turritella, Turbo, Crassitella, Natica, Pectunculus. Total, 6 sp., all extinct.

Hokitika.

Fusus—2 sp., Dentalium, Voluta—2 sp., Natica, Limopsis, Trophon, Turritella, Leda, Pecten, Ancillaria, Cassis, Venus, Pectunculus. Total, 15 sp.: recent 13, extinct 2.

Waipara.

Fusus—2 sp., Natica, Turritella—2 sp., Scalaria—2 sp., Struthiolaria—2 sp., Crepidula—2 sp., Calyptræa, Voluta, Cucullæa—4 sp., Dentalium, Echinite—3 sp., Trochus, Shark's tooth, Crania, Pectunculus—2 sp., Waldheimia—4 sp., Ostrea, Venericardia, Myodora, Pecten—5 sp., Venus—2 sp., Mactra, Mytilus, Modiola, Lucina, Panopæa, Cytherea, Artemis, Lima. Total, 48 sp.: recent 27, extinct 21.

AWATERE.

Fusus—3 sp., Voluta—2 sp., Natica, Turritella—3 sp., Struthiolaria—*6 sp., Crepidula—3 sp., Calyptræa,* Trochita, Ancillaria, Balanus, Pectunculus, Ostrea—2 sp., Pinna, Mactra, Lutraria, Artemis, Tapes, *Tellina, Cucullæa,* Dentalium, Purpura. Total, 34 sp.: recent 26, extinct 8.

MOTANAU.

Fusus, Voluta—2 sp., Natica—2 sp., Struthiolaria—3 sp., Turritella, Crepidula, Venericardia, Pecten, Ostrea, Terebratula, Cardium, Pectunculus, Mactra, Dosinia, Artemis, Tapes, Venus—4 sp., Sanguinolaria, Lutraria, Cucullæa—2 sp., Dentalium—2 sp., Tellina, Mytilus, Trochus, Nerita, Balanus, Rotella, Imperator, Pholas, Saxicava, Pinna, Modiola, Struthiolaria. Total, 42 sp. : recent 34, extinct, 8.

WANGANUI.

Murex—3 sp., Fusus—6 sp., Trichotropis, Trophon, Mangelia, Triton, Buccinum—4 sp., Purpura, Lymnæa, Ancillaria, Cassis, Trochus—2 sp., Imperator, Rotella, Pleurotoma, Auricula, Cerithium, Turritella—3 sp., Scalaria, Mytilus—2 sp., Ostrea—3 sp., Pinna, Modiola—2 sp., Venus—8 sp., Dosinia, Terebratula, Terebratella, Waldheimia—3 sp., Rhynchonella, Cardita, Tapes, Artemis, Lucina—2 sp., Cardium—3 sp., Venericardia, Natica—3 sp., Voluta—2 sp., Struthiolaria—3 sp., Pileopsis, Crepidula—3 sp., Calyptræa, Trochita, Emarginula, Hemitoma, Lima—2 sp., Balanus, Echinus, Echinarachnius, Turbinolia, Vermetus, Teredo, Coral—2 sp., Bryozoa (?), Pecten—7 sp., Mactra—3 sp., Arca, Chamostrea, Nucula, Corbula, Tellina—2 sp., Lutraria, Panopæa, Mya, Pectunculus—4 sp., Mesodesma—3 sp., Donax, Psammobia, Sanguinolaria, Myodora. Total, 121 sp. : recent 109, extinct 12.

Grand Total, 290 sp. : recent 229, extinct 61.

ART. XL.—*On the Tertiary Series of Oamaru and Moeraki.** By CHARLES TRAILL.

[*Extract from a letter to Dr. Hector, May* 25, 1869 ;—*read before the Wellington Philosophical Society, September* 18, 1869.]

I BEG to communicate some observations concerning a formation which, in this district, rather puzzles me. I call it the "Blue clay" formation for want of a better name, that being the usual term for the principal deposit of it that I have seen. Very near Hampden, a well, sunk by Mr. Gleeson, for, I believe, 300 feet, did not penetrate through it; but it is often yellow or yellowish-brown, and not unfrequently forms hard rock, as you are doubtless aware. I myself have not noticed it north of the lower Waitaki, south of the Moeraki boulders, or west of Mr. Feren's station on the Kakanui, but have seen specimens of it from other parts of Otago and Canterbury. You probably know whether the Awatere blue clay contains similar fossil remains or not.

Some time since I was endeavouring to work up the fossil shells of this formation, with the view of determining approximately the proportion that has become extinct.

Of course, in a collection of fossils, we must expect a number on which we cannot pronounce with certainty, by reason of their imperfect condition, as I need hardly say ; but I have been at pains to procure and lay bare, at least one good specimen of each species, so as to reduce the doubtful cases to a comparatively small number. Striking these off until further light is thrown on them, and reckoning, on the one hand, those between which and the recent I am unable to distinguish any difference ; and on the other hand, those which

* See *Mantell,* "Quart. Journ. Geol. Soc.," Vol. vi., p. 333.—ED.

are clearly distinct; I feel now pretty confident that we must consider more than one-half of the species to have become extinct in our seas. This alone, if confirmed by further and more extended observations, would, I presume, prevent this formation being referred to any period later than the Miocene; though, as far as I can make out, by the works I have by me, it has always been considered as Pliocene or Pleistocene, (see Hochstetter's "New Zealand," p. 61—"Younger Tertiary Strata," etc.)

Doubtless some of the species *may* be extinct here, and alive elsewhere, but I fancy this is improbable. The presence of several of the genera, as Cassidaria, Conus, etc., seems to indicate, if anything, a somewhat warmer climate, but I see no approach to the shells of Port Jackson, in the latitude of the North Cape.

Of the Chilian shells (I did pick up shells there ages ago), I have little recollection.

It appears to me, however, that the proportion of extinct species is much less striking than the number of extinct genera. Woodward writes, p. 421, "The shells of the newer tertiaries, are always identical, at least *generically*, with those of the nearest coasts." But here we have the following genera, none of which, as far as I know, have been found recent.

Typhis (the Rev. Mr. Taylor's Typhis, was, I think, a *Murex*), Pyrula, Cassidaria, Conus, Sigaretus, Turritella, Avicula, Perna, Cucullæa, Limopsis, Crassatella, Mya, with one of the sub-genera of Natica.

I shall append a list of all the genera I have determined, and when you come this way I can show you these and other specimens.

LIST REFERRED TO.

(The extinct species are marked in italics.)

Muricidæ (14)—*Murex*, *Murex* sp. (?), *Typhis*, *Triton* 2 sp., *Fusus* 7 sp., *Trophon*, *Pyrula*.

Buccinidæ (6)—*Buccinum*, Buccinum 2 sp., *Cassidaria*, Nassa, Ancillaria.

Conidæ (3)—*Conus*, *Pleurotoma*, *Mangelia*.

Volutidæ (5)—Voluta 2 sp., Marginella, *Marginella* 2 sp. (?)

Cypræidæ (1)—*Cypræa*.

Naticidæ (4)—*Natica* 2 sp., *Polinices*, *Globulus*, *Sigaretus*.

Pyramidellidæ (1)—Chemnitzia.

Cerithiadæ (2)—Cerithium, Struthiolaria 2 sp.

Turritellidæ (2)—*Turritella* 2 sp.

Litorinidæ (1)—*Solarium*.

Turbinidæ (1)—*Trochus*.

Calyptræidæ (1)—Calyptræa, *Crepidula*.

Dentaliadæ (3)—*Dentalium*, Dentalium 2 sp.

Tornatellidæ (1)—*Tornatella*.

Bullidæ (2)—Cylichna 2 sp.

Rhynchonellidæ (1)—Rhynchonella.

Ostreidæ (5)—*Placunomia*, *Lima*, Limatula, *Pecten* 2 sp.

Aviculidæ (3) *Pinna*, *Avicula*, *Perna*.

Mytilidæ (1)—Modiola.

Arcadæ (5)—Arca, Cucullæa, Pectunculus, Solenella, *Limopsis* 2 sp.

Cardiadæ (1)—*Cardium*.

Lucinidæ (1)—Lucina.

Cyprinidæ (2)—*Crassatella*, *Venericardia*.

Veneridæ (3)—Venus 2 sp., Artemis.

Mactridæ (1)—Lutraria.

Tellinidæ (1)—Tellina.

Myacidæ (2)—*Mya*, *Corbula*.

I presume this formation has been generally considered to overlie immediately the Oamaru building stone.

At one point near the south side of the Oamaru Cape Cliffs, just below where the hill slopes away southwardly, may be seen the "Blue clay" with its underlying rocks. At first sight it seems to be a horizontal bed, capped by a seam of yellow clay; but a closer inspection shows that there are hard seams, several inches thick, running through it, dipping to the south; and that these show the original planes of stratification, is evident, because the imbedded fragments of flat shells, and thin seams of shells, lie in parallel planes. Also, the same rocks form, at this place, outlying reefs, dipping in the same direction, having the soft parts eaten away by the action of the waves, so that the upper part of the clay and adjoining rocks (on which lies a single layer of hard water-worn limestone, say six inches to a foot in thickness), must have been worn to a level, and the upper portion of the clay altered in colour, after being tilted by the force of the volcanic outbursts which formed the Cape hills.

Interposed between the "Blue clay" and Oamaru stone, is a layer of sand like that in Hutchinson's lime kiln, containing numbers of Terebratulæ, Pecten, Hutchinsonia, etc., and irregular masses of dislocated rock, altered, I suppose, by heat.

On looking over the foregoing I think you may add to the previous list of fossils, one new species of Limopsis, and one new Struthiolaria. (List amended.) The Struthiolaria (of a genus you may remember peculiar to *our* shell province) is interesting, as showing a marked approach to the genus Aporrhais. Comparing it with *S. straminea*, the body is more slender, the mouth more expanded, and the outer lip, instead of having two slight rounded projections, has one claw-like expansion. A fine Turritella, of which you have at least one specimen from the Waitaki, attaining a circumference of about four and a half inches, is not uncommon, and I have one Scalaria (which seems common to this and the Oamaru stone) about four inches in circumference. It is singular that the only shell retaining any colour is a large Lima, of which genus I believe all the recent species are destitute of colour. Possibly, however, the colour has been induced by chemical action, during its long sojourn in the clay; and this shell was, perhaps, in its day and generation, of as pure a white as its descendants of our times. I have one valve of this Lima, measuring five inches in length. The list I sent you contained seventy-five genera, with the two now mentioned, seventy-seven, of which I believe fifty-one to be extinct, and twenty-six perhaps alive; but I have more confidence in the dissimilarity of the fifty-one, than in the similarity of the twenty-six; and I have a number of imperfect shells and fragments, evidently different from any we have found recent, but of which I have not yet been able to determine even the family; so I think it not unreasonable to suppose, that the proportion of extinct is understated above.

Without presuming, of course, to speak positively, I cannot help a strong impression that these results indicate a much higher antiquity to this formation than has been hitherto assigned to it. As far as I have seen it noticed, it is put down as Pliocene, or Pleistocene*—a time I suppose when nearly the present disposition of land and water obtained; while if it has to be referred back to the Miocene, or possibly the Eocene, we must imagine a period when these islands bore only a rude general resemblance to our New Zealand of to-day. (?) Even on this spot, I think it can be shown, that when these

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* A series of fossils from this formation, now in the Dunedin Museum, was exhibited in the Geological Survey Collection, in the N. Z. Exhibition, 1865, as *Eocene*. See "Catalogue of N. Z. Exhibition," p. 58; and "Juror's Reports," p. 263.—Ed.

shells flourished, there was no "Oamaru Cape," which now gives a friendly shelter to our coasting fleet; as it is also tolerably plain that a spacious harbour or inlet then existed, where the waters of the Waitangi now traverse an extensive agricultural district.

The following, I think, to a common mind—perhaps not to a trained geological one—seems to bear further testimony to the age of these shells:—

In various parts of this coast the face of an old sea-beach is seen, often elevated considerably above the present one, and supplying the shingle from which the present coast is formed. This is covered by many feet of silt. The inference surely is, that *since* this old beach was formed, we have had at least one considerable depression (to allow of the uniform deposition of such a depth of clay over many miles of surface) and one subsequent elevation.

If, in our day, there is little or no sensible movement going on in this part of New Zealand, we may surely conclude that the two movements, referred to, represent a very lengthened period. Yet the fossil shells in this old beach seem precisely similar to those now living; then, how immensely old, by comparison, must this group of shells be, in which only a few bear any close resemblance to those we now find. As bearing on this, and because we often hear it assumed that the coast is rising, the following may be worthy of note:—

At the mouth of the Awamoa, and, I believe, at various creeks on the coast, we find evidence of old Maori repasts, where moa bones (many of them broken, and the fractures still sharp, not waterworn) are associated with those of the seal, marine shells, such as Maoris still collect for food, chert flakes, etc., in a black soil, apparently a mixture of sand and charcoal. I believe those who have studied the matter consider that it is a long time since Maoris feasted on moa flesh, and that these particular deposits are amongst the earliest records of human life in these islands. Yet while exploring at this place with spade and pick, I was on two occasions "washed out of my diggings" by the sea at spring tide, showing that the deposit is now only slightly above high-water mark, while we may safely assume, that, if lower by only a foot or two, such a friable soil could not long withstand the violence of the sea on an exposed coast. While taking out some egg shells (moa) at this place, I found, at about twelve inches below the surface, a small bit of ivory resembling one half of a long squarish bead, split down the centre longitudinally. I am not aware of any hollow ivory tusk it could be made of, and it is difficult to conceive how the hole could be bored without the use of an iron tool. I shall enclose wax impressions, which may interest Mr. Mantell,—like showing him a nugget from his old diggings.*

Art. XLI.—*Account of a visit to a Hot Spring called* "Te Puia," *near Wangape lake, Central Waikato, Auckland; in August,* 1868. By R. Gillies.

[*Read before the Otago Institute, November* 2, 1869.]

Most of you are aware that in the North Island of New Zealand a series of natural wonders exists, such as are unequalled in any other part of the known world, in the shape of thousands of hot springs, fumaroles, mud-volcanoes and solfataras. Some of them are of the grandest and most beautiful character, and will yet, when the Maori difficulty is effectually disposed of, draw to our shores crowds of scientific and delighted observers. The district in which these principally occur extends from the active volcano of Tongariro, in the

* See *Mantell*, loc. cit. sup. Also "Trans. N. Z. Inst.," Vol. i., p. 18.—Ed.

Province of Wellington, in a north-easterly direction, along the Upper Waikato, through Lakes Taupo, Rotorua, Rotoiti and Rotomahana, to the White or Sulphur Island, a solitary, but active volcano situated in the Bay of Plenty, many miles at sea. But the spring which I ask you to visit with me to-night is not situated in this zone or belt of active volcanic agency, nor does it possess any of the grand or even beautiful characteristics which belong to the world-renowned "Orakeikorako," "Rotomahana," or "Rotorua" springs. Still it has an interest of its own, especially to Otagonians, to whom a hot spring of any sort is a natural wonder not discovered as yet within their borders, so far as I know.

"Te Puia," as the Maoris call it, is situated about forty-five miles, as the crow flies, south of Auckland city, on the banks of the "Mira," a stream flowing from the west into the Wangape lake, in the Central Waikato basin. A drive in the coach of about thirty-two miles along the main south road, brings us to Point Russell, an incipient township on the banks of the noble Waikato, just past Koheroa, the scene of the fight of 17th July, 1863. Taking steamer here, and proceeding about thirteen miles up the beautiful river, often with the branches of peach trees, which grow luxuriantly on its banks, brushing the paddle-boxes of the steamer as she follows the windings of the deeper channels, we pass "Meremere," another spot memorable in the 1863 war, alike for the strength of its position, and the ludicrous incident which accompanied its evacuation by the Maoris, and disembark at the mouth of the Wangape creek, just below Rangiriri, the bloodiest of all the battle-fields in the Waikato campaign. With the assistance of a Pakeha-Maori friend who accompanied us (I say "us," for my wife accompanied me, and was the first white woman who ever visited "Te Puia"), we here engaged a Maori canoe and crew to take us up the Wangape creek and lake, to within about five or six miles of the spring. This part of the journey was something enchanting, the smooth easy motion of the canoe, the beautiful scenery of the lake (whose name I was told denotes "a large sheet of water"), and the measured cadence of the paddles, as they dipped simultaneously to the musical "Tupari, Tupari" of the Maoris, interrupted occasionally, as we passed native settlements, by the peculiarly shrill Maori cry of welcome, "haere mai," or of enquiry as to who we were: all gave an interest and pleasure not often met with in New Zealand travelling, just in the least degree marred, in our case, when we remembered that we were going into a part of the country which, though perfectly safe, had not been often visited by Europeans. At sunset we landed at the head of the lake, and were accommodated in a nice raupo whare, for the three days during which we made this our head-quarters—our Maori hostess dispensing her hospitality with a kind and liberal hand. From this place, a journey of two hours, on foot, the last half mile through a low-lying swampy Kahikatea forest, brought us to "Te Puia."

This name "Te Puia," though given by the Maoris living in the vicinity specially to the spring now under consideration, appears to have a more general application as well, and to be the generic term for a certain description or class of hot springs, as will appear from the few following remarks of Dr. Hochstetter, which I take the liberty of reading, as I am aware there are not many copies of his work on New Zealand, in Otago. (Page 391.)

"The phenomena are similar to those upon Iceland, and as the Icelanders distinguish their hot springs as Hverjar, Namur and Laugar, so also the Maoris make a similar distinction, although not quite so marked, between Puia, Ngawha, and Waiariki. The Hverjar upon Iceland are either permanent fountains, whose boiling water is continually in a state of ebullition; or intermittent ones, whose water shows a vehement ebullition only at certain periods, when it reaches the boiling point, while during the intervals it is in a

state of calm repose, its temperature often falling considerably. To the Hverjar belong, for example, the celebrated springs of Haukadal, the great Geyser and Strokkur, and with these the Puias of New Zealand correspond. The word Puia is especially used in the Taupo country, to designate the intermittent, geyser-like fountains of Tokanu, of Orakeikorako on the Waikato, and of Whakarewarewa on Lake Rotorua. Puia has, moreover, the more general meaning of crater or volcano, and is applied to active as well as extinct volcanoes. Namur, upon Iceland, are the non-intermittent springs, such as the solfataras of Krisuvik and Reykjahlid, having no periodical eruptions ; and the same are in New Zealand the Ngawhas, a term specially used for non-intermittent springs, for the solfataras and sulphurous hot-springs on the Rotomahana, Rotorua, and Rotoiti. Finally, the springs suited to bathing purposes, the water of which never reaches the boiling point, and all naturally warm baths are called 'Waiariki,' corresponding to the Laugar of Iceland."

From this it will be seen that "Te Puias" are intermittent springs, whose temperature varies considerably at different times ; a phenomenon which seems to be characteristic of this individual spring, as will appear from certain considerations to be mentioned further on. This is an incident worthy of note, as corroborative of the correctness of Hochstetter's general observations and deductions, and illustrative of the general prevalence, amongst the Maoris, of certain terms for certain classes of phenomena. Hochstetter never visited this spring, was never any nearer to it than the Waikato, and yet, here we find the same term applied amongst one tribe, which he found prevailing amongst other and totally different tribes, at least one hundred miles from this.

For some distance before reaching the spring, the heavy air of the swampy forest is impregnated with a sulphurous odour, occasionally to the extent of being very offensive, and about ten chains from our journey's end, the bush track, which we followed, brought us to the stream which flows from the spring. Speaking from memory, this stream was from two to three feet wide, of a similar depth, and running with a considerable current. It was clear, with a bright but dark-green deposit, or, as I at first thought, with fungus plants growing in the bottom. Steam was rising all along its course, and it was so hot that you could not hold your hand in the water. The creek was about four feet below the general level of the flat, and the bank sloped easily down to the edge of the water. On this bank no herbage of any sort was growing, but whether the red unclothed soil was the result of anything peculiar in the water, or of recent floodings of the creek itself, I cannot pretend to say ; I rather think of the latter, however, as evidences were not wanting of recent inundations. Following up the creek, and scrambling through some thick undergrowth in the otherwise open Kahikatea bush, all of a sudden we come upon "Te Puia."

I confess I felt disappointed on seeing it. From what I had read of hot springs, I expected to have seen a nice circular basin, with its sides encircled by silica or lime ; a clean and graceful punch bowl on a gigantic scale, with a funnel or tube descending from the centre, from whence proceeded all the "hubble-bubble, boil and bubble," with which our ideas of subterranean igneous action are generally associated. I might then have let my imagination loose for a time, and pictured to you fairy nymphs with angelic forms laving their graceful limbs in the enchanted bath, whilst sylvan satyrs kept watch and ward in the dark recesses of the forest around. But alas, nothing could be more prosaic than this ugly dub of water, more like a duck or horse-pond than anything else. Along one side and one end, the bush came close to the pond's edge. On the other side and end, the bush was cleared for a space of about ten feet, on the average, as shown in the sketch. There was no hollow, or head of a gully, or anything of that sort, to indicate that water might

be expected there; and any one approaching the spring from the side on which the bush grows thick, and close to the water, might, just as likely as not, plump headlong into the hottest of the water before being aware of its existence.

"Te Puia" is simply a sudden pool in the flat forest land, with the water about two feet below the general level around, and with a perpendicular clay bank forming its margin all round. The pool is somewhat the shape of a kidney potatoe, and measures along its greatest length, between perpendiculars from each end, sixty-eight feet, and in the same manner across, twenty-one feet. The depth of the pool I could not measure, as the Maoris have wisely filled it in, to within about three feet of the surface of the water with branches of trees, so as to afford any poor beggar, who might accidentally tumble in, a chance of getting out again before being parboiled. A log is placed across the pool, just above the surface of the water, to enable the natives visiting it to take advantage of the hottest part for cooking their potatoes, eggs, or "kai" generally. At the only part where it is at all possible to bear the heat of the water logs are also placed, coincident with the surface of the water, for the convenience of bathers. Nor let it be supposed that these rude appliances were at all unnecessary. I can assure you that it would take more nerve than I am possessed of, to have induced me to walk out on the log at the hottest part. I am not much afraid of water, but to run the risk of being boiled alive is quite another thing, and would make most men pause before risking it uselessly. In order to get the temperature of this part of the spring, I adopted another plan than that provided by the Maoris. I cut a long pole in the bush, and tied my thermometer by a string to the end of it, and thus dipped it into the hottest part. However, I found the logs at the other part of the spring of the greatest service, when I had prepared myself for a bath, and when, of course, the lady portion of the party had satisfied their curiosity and retired. At first I could only stand on the log, and dip the tips of my toes in the water, and gradually, inch by inch, descended deeper, till I was able to introduce my whole body up to the chin. Whilst thus immersed, my sensations were too hot to be pleasant. Every moment I felt as if the crown of my head was coming off, I was however determined to *do* the hot spring thoroughly, and knew that assistance was at hand to take me out at once had I fainted. To move much in the water, or bathe, in the ordinary acceptation of the term, was too painful to be endured.

Before disturbing the pool, the water was clear, and of a faint-blue tint; the branches, etc., forming the artificial bottom, being covered with the same bright malachite-green deposit, I have mentioned before as characterising the stream which flows from it. What this beautiful green deposit is I cannot say. On disturbing the water, however, it disappeared immediately, and the whole pool became of a white milky colour.

At the hottest part the water was *not* boiling, but effervescing like ginger beer, and vapour occasionally rose from it. Here I found the temperature, by an ordinary tin thermometer, to be 168° Fah., a foot below the surface. At the place where I bathed the temperature was 113° Fah. The temperature of the air at the same time being 68°. The Maoris said that the spring was not so hot at that time as it sometimes is, and that they often cook their potatoes and other kai, quite easily in it. At the above temperature (168°) they could not do this, and I was inclined then to view this and other stories which I heard of scalding pigs, boiling eggs, etc., to be myths rather than actual facts, till Dr. Hector suggested to me the likelihood of its being an intermittent spring; and since perusing the remarks of Hochstetter, which I have read to you, upon the name "Te Puia" being applied, in general, to all intermittent springs whose temperature varies; and also some remarks of Captain Hutton

upon this same spring, recorded in the "Transactions of the New Zealand Institute," Vol. i. p. 71. I think it is very likely that my unbelief was more at fault than the Maoris' facts.

Before disturbing the water, I filled two square gin bottles, which I had brought with me for the purpose, from the hottest part of the spring, and sealed them up at once to prevent the escape of gases. One of these bottles of water was afterwards forwarded, through my brother, to Dr. Hector, and is the bottle of water the analysis of which is given on page 71 "Transactions N. Z. Institute," Vol. i. The other bottle had a more inglorious, and somewhat ludicrous, end. The excess of my care of both bottles caused me to place them on a shelf in the raupo hut where we were entertained during our stay, and one day some "old hands" (surveyors' men) were having dinner in the hut, I was outside, making a sketch of the beautiful Whangape lake, when one of the Maoris came rushing out in a very excited state, gesticulating for me to come at once. I saw something was wrong, and on going in, found one of my bottles, which I had strictly charged the Maoris to take great care of, in the hands of one of these civilized white men, with the top part of the bottle broken off, and only a very little water left in the bottom. "Oh Sir," says the fellow, "please Sir, it busted." I suspected at once that it was not any peculiarity of the water that had caused the "busting," as in that case the whole of the water would have been gone, and the shelf, on which the bottles were lying on their sides, would have been wet. I said nothing, however, and after they were gone I found my conjectures correct, and that these men, in their insatiable love of drink, had jumped to the conclusion that the bottles contained gin, took one of them down and gave it a friendly tap on the head. The Maoris interfered too late to save it from their lawless greed, but the explanation that it was water from "Te Puia," suggested at once the excuse that it "busted." I drank some of this water and found it tasteless.

With reference to the medicinal properties of the spring, I may state, that a surveyor in the district informed me that on one occasion he was very ill with rheumatism, and that he camped close to "Te Puia," and by repeated bathings in the water for a fortnight, taking care to cover himself well with blankets after each immersion, he was thoroughly cured, and has had no return of the malady since.

"Te Puia" also forms a very good barometer for those living within sight of the valley, as, before the advent of rain a column of vapour is invariably seen rising from the spring.

There are several other hot springs in the same valley in which "Te Puia" is situated, but I was told they were all smaller.

The valley of the Mira is a deep precipitous glen, but from its being densely wooded, I can say nothing about its geological character, except that a bold white cliff which I observed on the opposite face of the glen, from where I descended into it, was said to be limestone.

As to the origin of these hot springs I should have liked to have read another extract from Hochstetter's "New Zealand," but I have detained you too long already, and must just conclude by referring you to page 432 of that able and deeply interesting work, which I regret to find is not so well known in Otago, as it deserves to be.

Art. XLII.—*On Improvements in the Processes for Extracting and Saving Gold.* By T. Heale, C.E.

[*Read before the Auckland Institute, November* 15, 1869.]

The quartz crushing machinery at the Thames is very excellent, and the appliances used for saving the gold ore are, I have no doubt, on the whole, as effective as is possible, consistently with the rapidity and economy required.

Nevertheless one occasionally hears instances of exceedingly conflicting and unexpected results—thus I find in a paper published a few days ago:

"Clarkson's machine.—One parcel of calcined stuff from the 'John O'Groat,' weighing only 11 tons, yielded 11 oz. 4 dwt. retorted gold. Another parcel of 11 tons uncalcined yielded 22 oz. 14 dwt., and 2 tons uncalcined stuff, crushed in the single stamper, yielded 8 oz. of gold. The battery is now crushing a 30 ton lot for the 'Pukehinau.'"

I am informed that care was taken that these several parcels should, as far as possible, be of uniform quality. And, in this Institution, on the 5th October, last year, a discussion arose in which it was stated that the use of the water from one source, as compared with another not apparently purer, caused a difference of one-third in the quantity of gold obtained.* Nor is it at all wonderful that occasional failures to save the gold by amalgamation should take place, when it is considered that for the amalgamation to be complete, every particle of gold must be brought into actual contact with mercury, the minutest film on the surface of either metal being sufficient to prevent their union, a circumstance which may arise either from the *sickening* of the mercury, as it is called, or from the gold having become coated with some repelling film derived from the liquids—as in the case named by Mr. Whitaker—or from the gases evolved in calcination, as in the case referred to from the "John o' Groat."

What then, in my opinion, is wanting is, not any improvement in the machinery and appliances now in use, so much as a ready and certain means of ascertaining by assay—which shall be trustworthy and at the same time not too expensive—whether or not the process is going on rightly, and all, or the great majority, of the gold present in the material is being saved; since if it should be found that appreciable portions of the gold are passing away with the tailings, it will generally not be difficult to ascertain the cause of the evil, and to apply an appropriate remedy, such as cyanide of potassium, or Mr. Crook's sodium amalgam, if the failure appeared to arise from the *sickening* of the mercury; or to a different treatment of the quartz, or the use of other waters, if the fault appeared to lie in their conditions.

The subject to which I wish to draw attention, and on which I would invite discussion, is the practical methods of assaying quartzoze and earthy matters supposed to contain small portions of gold. Now since the commonest observation shows that gold is never equally distributed through the mass, and since it is probable that after every care in pulverization the gold may still remain in particles of appreciable size, it follows that a very small sample can never be depended upon as representing the mass, and therefore that the delicate analytical processes of the chemist, which can only be used on very small quantities, are not adapted to the practical uses of the gold-miner. Now 1 oz. of gold to the ton is equivalent to 1 part in 32,666, or 1 grain in $4\frac{2}{3}$ lbs. avoirdupois, therefore it is convenient to take this quantity, or an aliquot part of it, for the assay, and in practice I think one-fourth of it, or $1\frac{1}{6}$ lb. will be found the smallest from which satisfactory results may be obtained, since in that quantity one-eightieth of a grain of gold will represent 1 dwt. to the ton.

* See "Trans. New Zealand Institute," Vol. i., p. 72.

Assuming then that $1\frac{1}{8}$ lb. is the smallest quantity upon which any assay can be satisfactorily made, it remains to be considered how such a quantity can be acted upon so as to separate any gold it may contain, with such precision as to attain certainty that the result shall be true to at least one-eightieth part of a grain.

Now the methods of assaying may be divided into three classes:—1st. Separating out the gold from the mass by a menstruum which will dissolve the precious metal, without acting on the earthy matter. 2nd. By resolving it into a form by which the earthy matter may be dissolved out, leaving the metallic matters free and in moderate compass. 3rd. Fusion of the whole with such a flux as would cause any gold or silver present to separate from the slag, either alone or in combination with lead.

This last practice, which is the dry assay proper, yields very certain and accurate results, but since the matters would require to be mixed with five or six times their weight of litharge, the quantities which I have stated as the minimum which could be used with advantage, would require the use of crucibles so large as to be exceedingly inconvenient and expensive; since a crucible could never be used twice.

The second method, as ordinarily practised by the chemist, of fluxing with carbonate of soda, would be still more inconvenient from the same causes, but a modification of the process, which I shall presently explain, appears to me the most likely one for easily obtaining reliable results.

In the use of the first method the menstrua which will dissolve the gold from the earthy matters are confined to two, viz., metallic mercury, and chlorine. Now the principal use for which assays of tailings are required, is to ascertain whether the mercury used on the ripple-tables and in the stamp-box has succeeded or not in dissolving the whole of the gold out of the material. If it has failed in doing so, the most probable cause of failure is that the particles of gold may have been coated with a film of some matter which prevented the contact of mercury with them. But if this is so, it is obvious that the same cause will be in operation to prevent combination when an assay is made by the same means, and that nothing could be more futile than to attempt to test the fact, whether the whole of the gold had been amalgamated by the mercury on the ripple beds, by repeating the very same operation on a sample, therefore I think it is demonstrable that any assay of tailings by amalgamation, is absolutely delusive and worthless.

The other method of solution, by chlorine, would be nearly perfect if the gold were in a state approaching to purity, or were it alloyed only with copper; but gold mixed with from one-third to one-half its weight of silver, as is the case generally with Thames gold, is precisely that modification which is insoluble in chlorine, the coating of chloride of silver formed, being sufficient entirely to protect the gold beneath it, from the solvent action of chlorine, unless the mechanical subdivision of the particles is absolutely infinitesimal.

We are thus left to the second method of dissolving off the earthy matter, and this must be done without the use of crucibles.

Now quartz is soluble in solution of caustic potash, at all temperatures, and at a temperature of about 300°, and upwards, the solution takes place readily and rapidly, if then the sample of earthy matters, mixed with about three times its weight of caustic potash dissolved in three or four parts of water, were placed in a clean iron vessel, in a steam chest, in which it could be subjected for two or three hours to the action of steam at a pressure of about 60 lbs. to the square inch—which corresponds to the temperature of 307° —the whole of the quartz, or at least with the exception of a few of the larger grains, would be resolved into a silicate of soda which would then readily dissolve out with hot water, leaving the gold and silver with oxide of iron and

alumina, or any other basis present, which would remain on the filter. A little dilute hydrochloric acid would readily dissolve out all except the precious metals, and these could then be either operated on analytically, or wrapped in a little lead foil and collected into a button on the cupel. The same thing might be done by placing the material in an ordinary mercury bottle, and subjecting it to heat in an oil bath; unless, however, good means were adopted for regulating the heat so as not to exceed 350°, or a pressure of 120 lbs. on the square inch, a danger of explosion might be incurred.

The solution of quartzose matters in this manner has been frequently employed, and I do not apprehend the smallest difficulty in its use; if iron pyrites were present in larger quantities, the sulphuret of sodium produced might possibly dissolve a little gold, unless a little nitre were added.

ART. XLIII.—*Notes on the Geology of the Outlying Islands of New Zealand; with Extracts from Official Reports.* Communicated by JAMES HECTOR, M.D., F.R.S., Director Geological Survey of New Zealand.

[*Read before the Wellington Philosophical Society, November* 13, 1869.]

THE Official Reports from which the following extracts have been made, were forwarded to the Museum, along with specimens of the rock formations, and I have thought the information they afford worth communicating to the Society, along with my own notes on the collections submitted.

1.—THE SNARES.

These small islands were visited by Mr. Henry Armstrong, in the course of the cruise of the brig "Amherst," which was undertaken in 1868, on behalf of the Provincial Government of Southland, for the purpose of landing supplies for the relief of cast-aways. Mr. Armstrong made the following remarks on them in his report.*

"The Snares are in lat. 48 deg. 03 min. S., long. 166 deg. 45 min. E., and under this name comprise two islands, a large reef to the N.W. of the main, three and a-half miles distant, and several outlying rocks. The small island (half a mile long), is separated from the main on its east side by a very narrow passage. The larger island I take to be about four miles in circumference. Greatest elevation, 600 feet. Coast line, very bold. It is almost entirely covered with scrub and trees of stunted growth, the Tupari, Akeake, and Kokomuka. Of M'Quarrie cabbage there is abundance, and of fine growth, some of the leaves measuring two feet in diameter. Patches clear of scrub are clothed with the Lutaki tussock. The soil is peaty, and well mingled with guano, and very moist. We found no water at all palatable, some I drank being quite brackish; but then, the birds would render the best undrinkable. Those who trade in mutton-birds, would find a visit to these islands, in March or April, prove remunerative."

"We pulled away for the N.E. side of the island, where is a small gulch or cove, the only boat harbour on it I believe. Thousands of mutton-birds, nellies, penguins, etc., heralded our approach, and to some extent prepared us for what we saw on landing. Once on shore our party was divided, and we commenced our search. I and two others made for the west side, where we climbed a high bluff, some 500 feet high, commanding a good view of the whole island. Our progress was painfully slow, the entire surface being literally honey-combed

* "New Zealand Government Gazette, Province of Southland," April 11, 1868, p. 51.—"Cruise of the brig 'Amherst.'" By H. Armstrong, J.P., M.P.C., acting on behalf of the Government.

with mutton-bird holes, into which the foot sank deeply at every step, the inmates thereof betokening their dissatisfaction at our presence by giving vent to a half-choked querulous cry. The penguins—ludicrous birds—in hundreds, drawn up in rank and file, stood to oppose us on our march, and it required not a little vigorous kicking to force our way through them."

Thirty-five specimens of rocks were obtained on the Snares, and in general appearance the collections resemble the rocks of the Dunedin peninsula. They consist of

1. Varieties of Basalt, both compact and granular, containing Augite and Sanidine crystals. 2. Claystone Porphyry, and tufaceous clay. 3. Chert and Jasper.

We may conclude therefore that the islands have been formed by one of the volcanic outbursts that took place towards the close of the Miocene period, along the south-eastern border of New Zealand.

2.—Campbell Island.

This island was also visited by Mr. Armstrong, and respecting it his report gives the following information:—

"Campbell Island (Erebus Point, lat. 50 deg. 32 min. S., long. 169 deg. 12 min. E.), is about eight miles from north to south, and the same from east to west. It is traversed by ranges of hills of considerable height—Honey hill, to the south, being close upon 1600 feet. The geological formation does not differ materially from that of the Aucklands. In West Bay, however, the cliffs are composed of chalk and beds of flints, resting on limestone. I had heard a rumour that copper was to be found here, but I saw no indications whatever of its presence. Iron pyrites may probably be present, and have given rise to the report. In Perseverance Harbour the geologist will be interested by the appearance of the basaltic dykes, of columnar structure, the pillars vertical, horizontal, and in one place radiating from a common centre, as though the basalt, forced up through a small orifice, had spread out in the shape of a fan. The ground is very uneven, which made our travelling toilsome, the foot constantly going into holes two feet deep. The soil is very wet and peaty, the surface between the tussocks (Patiti) carpeted with beautiful mosses and lichens of most varied hues; even the branches of the scrub are so clothed—an unerring indication of the humidity of the climate. The M'Quarrie cabbage, cotton plant (I have an idea that good serviceable paper might be made from the latter), and wild carrot grow abundantly forming most excellent feed for the pigs which we put ashore. The inevitable Piri-piri appears everywhere. Of timber proper, there is none on the island. It would take a boat's crew a considerable time to collect a supply of firewood, the scrub being of the very smallest growth. There is no Rata, and the Enaki is of a smaller and finer species than that of the Aucklands, and bears a small white bell-shaped flower, with a strong perfume, as of hawthorn. There are, of course, copious supplies of water of an excellent kind. This island seems to be the favourite haunt of the larger sea birds, the molly-mawks frequenting the north-east side; the albatross affecting the ranges between the north and south harbours; mutton birds *par-tout.* I think Nature has contented herself with fitting up this island for the reception of such birds—and pigs. The (so called) highland albatross (the noblest of all sea birds) lays but one egg in a nest raised about ten inches from the ground. The young birds were just breaking the shell at the time of our visit. The grey duck is found here. Of land birds I only saw the common ground lark and a small bird like the wren. Rats are numerous, and of a large size. No traces were seen of the pigs, game cock, hens, and geese, landed by Capt. Norman, of the 'Victoria.' The barometer, during our stay, stood at 29·20; average temperature of the air, 51°."

The collection from this island contains twenty-five specimens, and, besides volcanic rocks belonging to the Doleritic series, is highly interesting from indicating the occurrence of sandstones of the same mineral character as we find in New Zealand among the Lower Mesozoic formation, and also true chalk with large flints but without fossils unfortunately that can be seen by the naked eye, though probably a microscopic examination of the chalk might reveal some characteristic forms.

There are also fragments of reef quartz with Phyllite or blue slate attached, so that there must be a considerable variety in the geology of the island, which is a true rocky island, and not a mere volcanic mass, built up by submarine eruptions.

3.—Antipodes Islands.

On referring to the description of this group in the "Flora Antarctica," and to the sailing directions published as late as 1868,* I find it stated that landing is impracticable on these islands, so that Mr. Armstrong's party appear to have accomplished the feat probably for the first time on record.

His report states, that—

"On Friday, 29th Feb., 1868, after having made more than one attempt to leave our anchorage in Campbell Island, we succeeded in getting out of the harbour, and with a steady breeze from the S.W., we soon ran the distance to the Antipodes Islands, making the land before daybreak on the 2nd March, and verifying their position as fixed by Capt. Norman. But for his observations we might possibly have ascertained their true position for ourselves, in a manner far from pleasant, the chart placing them some fifty miles to the eastward, and ten miles to the north. When close to the island, we fired our gun, and lowering a boat, I went ashore with an officer, effecting a landing very easily under the lee (east side), although a considerable sea was running outside. Firing the grass as we went, we made for a hill in the centre of the island, which we climbed, and from its summit carefully scanned the whole surface around. We saw nothing but the tussock waving in the wind, the albatross sitting quietly on their nests, and a few parroquets flitting about. We remained four hours here; the men spread out in different directions, and then returned to the boat with the conviction that no human beings (with the exception of ourselves) were present on the island. Before leaving, we placed a board on a high rock, securing it with stones, on which is carved, 'Brig Amherst, in search of castaways, March, '68; by order of the Government of Southland.' With it, two bottles, one containing some matches, a flint and steel, fish-hooks, and a parcel of dressed flax; the other, a letter, in which I mentioned what had been done on the Auckland and Campbell Islands, etc.

"The Antipodes Islands (two, a small one lying about half-a-mile off the S.E. end of the main), are situated in lat. 49 deg. 42 min. S., long. 178 deg. 43 min. E., the coast line bold and rugged, the cliffs having a weather-beaten bleached appearance. The main island is about three miles from east to west, and two and a-half miles from north to south. Greatest elevation, 700 feet, the hills dotted with high tussock (pa-ti-ti), and patches of M'Quarrie cabbage and cotton plant. The soil is peaty, but drier and firmer than that of Campbell Island; of scrub, there is none worthy of the name, scarcely enough to make a good fire with. The albatross here is the 'lowland,' and lays two eggs. To walk across country required a little circumspection, progress being made by hopping from tussock to tussock, a false step causing the unwary one to subside up to his chin amongst the grass and piripiri. It reminded me forcibly of crossing swamps in our own province, on top of the Maori-heads. The

"Description of the Outlying Islands, South and East of New Zealand," p. 16: printed for the Hydrographic Office, Admiralty, 1868.

rocks on the island are purely volcanic. Close to where we landed are large beds of ashes, and ferruginous scoria. From this and other indications, the conical shape of all the hills, and their rounded tops, I am of opinion that the island has been the site of an active volcano."

The rock specimens obtained, twelve in number, support Mr. Armstrong's view of the geology of these islands, which appear to have been formed by volcanic eruptions, at first submarine, as shown by the specimens of Dolerite with large crystals of Augite, and true Phonolite or Clinkstone, but latterly the eruptions must have been subaerial, as the other specimens are scoriaceous lavas, and fragments of volcanic bombs, exactly resembling the volcanic rocks of the northern parts of New Zealand, especially near Auckland. No specimens of older rocks are represented in the collection.

4.—Bounty Island.

Respecting Bounty Island, Mr. Armstrong states, that—

"They are a group of naked detached rocks, extending from N.W. to S.E. about two miles. The sea rose in spray to the tops of the highest (some 100 feet), and breached clean over the lower ones. There are several outlying rocks awash, at some distance from the main body. Of course no attempt could be made to land, but we saw every rock distinctly with the naked eye, and had there been anything as large as a goat moving on them we must have perceived it. Neither man nor beast could exist on the Bountys, and had I known their nature, I would not have deemed it necessary to visit them."

5.—Auckland Islands.

This group is better known than any of the others, and collections have been received from Mr. Armstrong, and also from Mr. J. H. Baker, Chief Surveyor of Southland, from whose careful report I make the following extracts:*—

"The Auckland Islands were discovered by Captain Bristow, in the year 1806, and formally taken possession of by him in the name of the King, when he visited them a year later. They were next visited by Admiral D'Urville's, and Commodore Wilkes' expeditions, in 1839. The vessels of the Antarctic Expedition also called at them in 1840, and during their stay Drs. Lyall and Hooker made a large collection of the different plants and shrubs indigenous to the islands, of which they published a full account in the first volume of the 'Antarctic Flora.'

"About this time the Auckland Isles seem to have been the favourite resort of the South Sea whalers, and in 1850 a large whaling establishment was started at Port Ross, in Rendezvous Harbour. The number of houses, now fallen into decay, and the large amount of work that has been done in clearing the scrub, would indicate that, at some time, at least two hundred people must have been located at this spot; and at that time the settlement must have been in a prosperous condition, as a surgeon of one of the whalers, in giving an account of a cruise in the South Seas, mentions the settlement, and remarks that in the course of time it would probably become a settlement of considerable importance; but in 1852 the whaling establishment was broken up, and the islands were totally deserted.

"The Auckland group consists of two large and several smaller islands—Enderby, Rose, and Ocean Islands—forming the north-western, and Green Island, the south-eastern, entrance to Rendezvous Harbour, situated at the extreme northern part of the island, in lat. 50 deg. 32 min. S., and long. 166 deg. 13 min. E. This harbour is of considerable size, and would afford shelter and secure

* "N.Z. Government Gazette, Province of Southland," 1865, p. 117, et seq.

anchorage to vessels of the largest description. It is nine miles in length, from the entrance between Enderby and Green Islands, to the head of Laurie Cove, which is only separated from the west coast by a short valley, ending in a saddle of considerable height. The site of the old settlement is situated on a low peninsula, at the entrance to Laurie Cove. It is the most level spot in the whole island, and even this can hardly be called level, as it consists of irregular mounds of peat, from which the dense scrub, with which it was originally covered, has been cleared away. The last vestiges of the old settlement have nearly disappeared, and in a few years it will be difficult for a stranger to find the site of Port Ross. Shoe Island is a remarkable feature in this port, as it lies in the centre of the harbour, half-way between the Heads and Laurie Cove, and is formed of basaltic rock, which takes the form of a shoe. It rises perpendicularly out of the water, which is of a considerable depth all round it.

"Basaltic Hump, which I see is called 'Deas Head' by Sir James Ross, in the 'Antarctic Expedition,' is another curious feature in this harbour. It is formed of a large mass of basaltic rock in perfect columns, which rise to the height of one hundred feet.

"The main island is nearly twenty-five miles in length, and the whole group from Enderby Island to South Cape on Adams' Island, in lat. 50 deg. 56 min., and long. 166 deg. 7 min., is about thirty-two miles.

"The main island is extremely narrow at the northern end, and gradually increases in width towards the south end, where it is fifteen miles across.

"Adams' Island is at the south end of the main island. It forms the south side of the entrance to Carnley's Harbour and its western arm.

"The east coast of the main island greatly resembles the west coast of Otago, on a miniature scale; being a succession of rocky headlands, which form the entrance to the remarkable inlets, which penetrate in most cases to within a few miles of the west coast of the island. The character and description of these inlets so much resemble each other, that it is impossible to give a detailed account of them; from the eastward there is so much sameness in their appearance, that it is difficult to distinguish one from the other, some of them having more the appearance of ravines between the mountains, than the entrances to harbours. Between Rendezvous and Carnley's Harbour there are six large bays, some of them being nearly landlocked, and five sounds or inlets. Most of these have two arms which are rarely more than half a mile in width and often not so much; in some of them we had only just room to swing the steamer. A small river, or rather a mountain torrent, runs into the sea at the head of each of them, but so steep and precipitous are the mountains, that some of these form waterfalls and cascades half a mile from the sea. One of these sounds I named Cascade Inlet, and I have seldom seen a more grand or magnificent sight than we saw here. One of the largest mountains on the island forms a semi-circular cone round the head of Cascade Inlet, and down the side of this mountain fell innumerable waterfalls and cascades of all shapes and sizes, and of considerable volume. All of them apparently spring out of the ground, and the white spray rising in clouds, when it reaches the rocks below, glistens in the sun, and gives them at a distance the appearance of masses of pure white marble. There had been a heavy fall of snow the night before, and at this time of the year it melts very quickly, which would account for the large amount of water that was pouring down when we were there.

"Basin Bay was another striking and interesting feature on the east coast. So evenly do the mountains rise up all round it, that one might almost fancy it had been scooped out of a tremendous hill, and that the bay was a little water at the bottom. Here, as at Cascade Inlet, the drainage of the hills falls in numerous little waterfalls, which have not as yet, as far as we

could see, made any impression on the side of the hill which might be called a water-course or gully.

"The entrance to Carnley Harbour, in lat. 50 deg. 50 min., is extremely narrow, being little more than a mile in width, the cliffs on each side being nearly perpendicular. The harbour is divided into three main arms, the northern, middle, and western. The northern arm is most exposed. It is here the 'Grafton' was wrecked. It runs in a north-westerly direction to within a few miles of the coast, being only separated by a low saddle which I overlooked from a high hill on the north side of the harbour. The middle arm is separated from the northern by a peninsula, the hill on it rising up in the shape of a beautiful cone. It is covered with scrub at the base, and grass at the top; the neck of this peninsula being only a few chains wide.

"The Middle arm has two round bays at its western extremity, and the large quantity of *debris* that has been brought down, by the mountain torrents, at the head of them, has formed two large flats extending across the bays nearly a mile from the shore, which are uncovered at low water. They are composed of angular fragments of rock and mud. Between the south head of this arm and Masked Island there is a deep bay, which, from the peculiar appearance of the mountain above it, we called 'Amphitheatre Cove.' The view of this bay from the harbour is strikingly beautiful. From about half way up the hill, which is nearly 2000 feet in altitude, basaltic columns rise in regular order (with a small intervening space) one over the other, to the top of the hill, which is one colossal mass of basaltic rock. These columns extend with few breaks entirely round the bay, in regular order, and the lowest columns are at least one hundred feet in height. They decrease in size towards the top of the mountain, or the elevation gives them the appearance of doing so.

"Camp Cove and Masked Island form the north head of the western arm. The former is perfectly landlocked, and forms a miniature harbour in Carnley's Harbour. It affords safe anchorage for vessels of any size, the depth of water ranging from twenty to four fathoms. It was here the 'Southland' was moored whilst we remained in Carnley's Harbour.

"Masked Island is just off the head of Camp Cove. It is very small, and seems to have been a favourite resort of seals, before they were disturbed by Captain Musgrave's party.

"The Western arm is extremely narrow, not exceeding two and a half miles in its broadest part. It is connected with the west coast of the island by a very narrow passage which has a small island in the centre, named by Captain Musgrave 'Monumental Island.' The tide rushes through this passage with great velocity, rendering it unsafe for any vessel to pass through; and with a strong westerly wind the breakers rushing through such a narrow gap, make the whole passage one sheet of foam, which in a strong gale must be a really magnificent sight.

"The south coast of Adams' Island presents an almost unbroken line of perpendicular cliffs, which extend in a south-westerly direction to the South Cape. On the west side of this cape a narrow inlet running in a northerly direction ends in an abrupt ravine. The entrance to this inlet is between two immense cliffs, which tower like walls to a height of several hundred feet.

From the South Cape, the coast line runs in a north-westerly direction to West Cape. A little to the east of this cape the entrance to the narrow passage running into the Western arm commences; on the east side of the entrance are two curious rocks, jet black in colour. They rise like two immense pillars, and mark the entrance of this dangerous passage.

"From the West Cape the coast trends to the north-east, almost in a straight line, to the north point of the main island, a distance of about twenty-six miles. This coast may *well be called* precipitous and iron-bound, as the

cliffs form a continuous wall, almost without a break, some of them overhanging one another, and attaining an elevation of at least six or seven hundred feet.

"The whole of the Auckland group is mountainous in the extreme. Nowhere did I see a flat of any considerable size, and 'the level plains covered with beautiful grass and refreshing verdure' (as quoted by F. F. Shillinglaw, F.R.G.S., the editor of Captain Musgrave's journal) is all a myth. I ascended to the top of the range on the west side of Rendezvous Harbour, and obtained a good view of the whole of the backbone range of the main island as far as Giant's Tomb (so named by Captain Musgrave), the most elevated hill on the island, situated on the north side of Carnley's Harbour.

"The main range commences at Mount Eden (1325 feet). This is the most remarkable feature at the north end of the island. The top of the hill is composed of an immense rock, which can be seen all the way up the east coast. It was ascended by Mr. Richardson, who describes it as being sixty feet in height, and of a considerable circumference at the base. From here the main range runs down the west coast, forming on the one side the immense cliffs and precipices observed there, and on the other throwing out spurs which form the dividing ridges, and headlands between the numerous inlets on the east coast. I only observed two breaks in the whole range; one about half way down the east coast, at a place we named Saddle Hill Inlet, because a saddle at the head of the inlet led directly across to the west coast. The other is nearly at the end of the range, being the saddle at the head of the northern arm of Carnley's Harbour.

"The range on Adam's Island runs nearly at right angles to the main range, and probably at an early period formed part of it.

"The shores of the whole of the Auckland Isles, with the exception of the west and part of the south coast, are covered with scrub for a considerable distance up the sides of the hills. In some places it is rather thick and difficult to penetrate; but in others it is very open, and not at all bad travelling, for such hilly country. The largest scrub is found round Carnley's Harbour. It consists chiefly of iron wood, and a tree called the black oak. Neither of these grow to any height. The iron wood grows to a considerable thickness, but is very knotty and irregular. It might be used for the knees of ships, but I did not see any fit for sawing purposes, the open land on the tops of the hills is all peat of a very spongy and wet description; in fact the whole surface of the island, with the exception of the rocks, is pure peat, and I can safely say that during the time I was there, I never saw an acre of ground that was not perfectly saturated with water; it can only be in very dry seasons that the surface gets thoroughly dry.

"The open country is chiefly covered with large tussocks of snow grass, cotton plant, moss and other plants indigenous to the island. The average temperature whilst we were at the islands was about 50 deg. I see that Sir James Ross, in the Antarctic expedition, gives the average temperature for the same month at 45·27.

"The whole surface of the islands, even to the top of the highest hills (Mr. Richardson and myself having ascended five of the highest), is covered with a deposit to a considerable depth of genuine peat (not lignite), similar in appearance and physical character to the peat of the Irish bogs. This when cut (as we found in one place at the old settlement in Rendezvous Harbour), from some distance from the surface and dried, becomes quite hard and firm, like the Irish turf, and produces the same cheerful and pleasant fire, altogether free from the usual suffocating smell of lignite. This deposit, as it rests directly on all the different rocks alike, might also form some clue as to the age of the formation of these islands."

The geology of these islands is exceedingly meagre, but not uninteresting. The rocks of which they are formed, judging from the specimens submitted, thirty in number, being as follows :—

1. Dolerites, claystones and basaltic porphyries.
2. Chert and pitch opal.
3. Tertiary sandstone and conglomerate with streaks of coal.
4. Bituminous peat, like that which is found on the Chatham Islands.
5. Fine-grained granite.
6. Granite porphyry, syenite and hornblende rock.

It thus appears to be a granite island, with patches of tertiary strata resting in hollows on its surface, and the whole overlaid, more or less, by volcanic rocks of post-miocene age.

6.—Chatham Islands.

The geology of this group has been made known to us by Dr. Haast's notes on the collections of Mr. Henry H. Travers,* but since then two important series of specimens of rocks and fossils, from the Chatham Islands, have been deposited in the Museum, accompanied by copious notes. The first consists of 200 specimens, forwarded in February, 1868, by Mr. Charles Traill; and the second, comprising 102 specimens, was received from Mr. Percy Smith, in March, 1869.

Notwithstanding the completeness of these collections, there is little to be added, from their study, to the information we already possessed.

The tertiary series, as in New Zealand, appears, however, to belong to two distinct epochs, the upper of which is alone associated with igneous rocks, chiefly dolerites. There also appear to be two distinct carbonaceous formations, the older occurring in Pitt's Island, representing the brown coal series of New Zealand, and a newer formation which may be considered as a modified peat, which is quite superficial in the district south of the salt-water lagoon. In this formation are large masses converted into a highly bituminous mineral, probably by the action of the fires described by Mr. Travers,† which might prove of considerable value, either as fuel, or for the manufacture of oil, and for the composition of which I may refer to the Laboratory Reports for 1868.

Among Mr. Traill's specimens are also fragments of flints, and of a calcareous rock resembling the chalk from Campbell Island.

The older tertiary limestones are much changed by contact with volcanic rocks, so that in part they are converted into true lithographic limestone, in the same manner as occurs in the vicinity of Oamaru in Otago.

The area of schistose rocks, exactly similar to the auriferous formation of Otago is, in the Chatham Islands, very considerable ; and reef-quartz of several varieties is represented in both collections, but no discovery of gold has yet been reported.

7.—Stewart Island.

This island should not properly be classed with the small islands previously alluded to as outlying islands of New Zealand, but, as an extensive series of rock specimens from it was forwarded at the same time with the other collections, I will include the notice of them in this communication. The collection was made by Mr. Walter H. Pearson, Commissioner of Crown Lands, Southland, in the course of an official visit round the island for the purpose of ascertaining where settlements could be advantageously placed. With reference to this point, Mr. Pearson states in his report :—

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* See "Trans. N. Z. Institute," Vol. i., p. 180.

† See "Trans. N. Z. Institute," Vol. i., p. 177.

"On the whole, I cannot but conclude that Stewart Island will prove, and that shortly, a very valuable and important portion of the Province of Southland. There are many industries which, dormant at present, will, when quickened into life, prove remunerative. Irrespective of any mineral wealth which may exist, of which I can only form a conjectural opinion from the singular appearance of the different strata of rocks on the south and west coasts of the island, I am of opinion that it will be well adapted for the small class of settlers—say fifty-acre men. From the peculiar configuration of the land, a large extent of it is rendered available by its frontage to the water. Its being covered with timber and scrub cannot form a very serious impediment to its settlement, inasmuch as in many parts of the North Island, heavily timbered land meets with ready sale, though in the interior; while the densely-wooded shores of Blueskin, Port Chalmers, and the harbour up to Dunedin, in the Province of Otago, were bought and cleared long before the fictitious stimulus to the price of land consequent on the discovery of gold.

"One of the most serious difficulties a young settler has to contend with in a new and sparsely-populated country, is the carriage of his provisions from the town to his land, pending his being able to raise sufficient produce to support himself and family off the ground he has purchased. He must either buy a team of his own or pay the heavy rates for carriage consequent on bad roads. These expenses, to a man of small means, are very heavy, and not unfrequently so crushing as to seriously retard his advancement. The means which would have enabled him to cultivate and improve his land with rapidity, are dissipated in the expenses of carrying his food. On Stewart Island much of this will be obviated. His fishing line and gun will supply him with one of the necessaries of life; and if he has a whaleboat, he can obtain the rest at no expense, so far as carriage is concerned, from the main land, or, if he has none, at a trifling cost, both in money and time, in comparison with land carriage. He will thus be in a better position to devote his energies and means to the clearing and cultivation of his land than his compeer, settling fifteen miles inland from Invercargill. I believe the sale of the timber would more than pay for the clearing in most of the bays. The admirable water communication would enable the logs to be floated or shipped to where a saw-mill might be established, and if it will pay to saw timber anywhere, it will at Stewart Island. At Port Pegasus, the splendid spars, and the knees, ribs, etc., of the rata, will always command a good price for shipment to the Mauritius—a trade with which is already established in Dunedin; vessels from the former place would only too gladly load with such on their return. Thus the cost of clearing the land will be less than on the main, while produce once obtained, the facilities for exporting it are greater. The local consumption of agricultural produce in all young settlements is not great, and the demand easily satisfied, the majority of the population being occupied in producing the same staple. To pay the agriculturist he must export, and on the main he is met with the usual difficulty—defective internal communication. The settler at Stewart Island will be in a very advantageous position in this respect; he has Nature's highway—the sea. He can boat his produce across to the Bluff, and ship it on board a steamer for Australia or the West Coast; or sell it to a merchant, delivering it as above. He will thus be enabled to sell it at a moderate price, and will consequently find a ready market.

"Shipbuilding is an industry which could be conducted with great success on the island, some of the bays in which are peculiarly adapted for the purpose. The numerous sheltered coves in Paterson Inlet and Port Pegasus, furnish a hundred dock-yards from which vessels of size could easily be launched, while the raw material abounds, and is of the best quality. I saw a vessel of 180

tons being built, every rib of which was formed out of the natural curve of the rata tree, the strongest and toughest wood for the purpose. I was also given to understand that there were one or two natural dry docks.

"The scenery is magnificent. At the south and west coasts of the Island, the weird appearance of the jagged mountains—the fantastic fissures in the bare rocky islands and coast, worn by the turbulent seas to which they are exposed—the lofty cones of bare granite—the singular colour of the rocks abutting on the ocean, unite in conferring a degree of grandeur to the tableau, such as I have not seen equalled in any part of New Zealand,—while the natural beauty of the landscape in Paterson Inlet and Port Pegasus is equal to that of the Sydney Harbour, setting on one side, of course, the artificial adjuncts of cultivated shores and ornamental villas.

"From all I could gather, and from my own observation, I would imagine that all along the east coast of the island, from Port Pegasus northward, the climate is fully equal, if not superior, to that of Invercargill. I had a good opportunity of testing it in every part of the coast during the five weeks I spent in exploring the island. Judging from the accounts I heard on my return to Invercargill, the weather on the main land must have been less fine than that I had experienced; nor do I imagine that a larger quantity of rain falls there than on the main. That drizzling rain is frequent is not surprising, seeing that the high range of hills running down the centre of the island naturally attracts and holds the cloudy vapours floating about, which are in some measure again discharged before being dissipated on the rising of the sun; but it is generally only an early shower, light and not lasting, which more assists than retards vegetation. I have no doubt that as the forests get cleared away in the progress of settlement, the climate will improve in this particular. From my experience, I would imagine the thermometer rises higher in the bays and bights on this island, than it does at Invercargill.

"The bays on the east coast are sheltered from the westerly gales by the high ranges already alluded to. The slopes of the hills have, as a rule, a north-easterly aspect, and the rays of the sun being concentrated by the contracted space into which they are poured, the heat obtained is greater. On more than one occasion I noticed how well sheltered the land in these bays is, when it was blowing half a gale outside.

"The distances of the various ports from each other, I have taken from the 'New Zealand Pilot.' I found the Admiralty survey wonderfully correct, so much so that the enlarged charts of the various bays would answer as selection maps under the present system of free selection, pending the ordinary survey of the island."

The rock specimens, sixty-three in number, are carefully distinguished as from the different localities, visited by Mr. Pearson, round the coast; but they only prove that there is a remarkable similarity in the geological formation throughout the whole of the island, consisting of granite, gneiss, mica-slate, felstone-slate, and other crystalline metamorphic rocks, associated with granite-porphyry, diorite, and syenite. No metallic ores are represented in the collection, but traces of copper and silver have been obtained from specimens sent from the western side of the island by prospecting parties.

Gold is obtained also in that quarter, as fine alluvial gold, on the surface of elevated terraces excavated in the decomposed granite. The gold is associated with large garnets, oxide of titanium, iron sand, and, occasionally, scales of platina, but this valuable metal is not so common, I am informed, along with the Stewart Island gold, as with that obtained on the opposite shore of Foveaux Straits, and in the Waiau river.

In 1863 I visited Port William and Preservation Inlet, which are both situated on the north-east side of Stewart Island. At the former I found the

rock to be a coarse-grained red or grey granite, which is traversed by veins of granite of more recent date and a lighter colour, and afterwards pierced and shattered by dykes and injected veins of hornblendic trap or greenstone. Most interesting sections abound, clearly displaying the facility with which the trap rock has penetrated the granite in all directions, most probably, however, only following and expanding previously-existing lines of fissure.

No minerals of interest or value were observed, although several might reasonably be expected to occur in this formation under the above conditions.

On the beach of one small cove that is surrounded by lofty cliffs, and situated in the north bay of the harbour, the sand is almost wholly of magnetic oxide of iron, in a very minute state of division, but neither gold nor tin was associated with it. The hollows between the ridges and bosses of granite are filled up with an unstratified deposit of stiff yellow clay, containing sub-angular boulders of large size.

In Paterson Inlet no other rock was observed but coarse-grained granite, which decomposes with great facility to a coarse sandy clay. This granite is irregular, from its containing nodules of compact fine-grained granite, so that it is probably only an extreme form of metamorphic rock.

In Ruapuke Island, at the eastern entrance of Foveaux Straits, it is worthy of note, that the granite and hornblende rock is traversed by quartz veins containing large masses of iron pyrites, that yield minute traces of gold.

ART. XLIV.—*Notes on a Collection of* SAURIAN REMAINS *from the Waipara River, Canterbury, in the possession of J. H. Cockburn Hood, Esq.* By JULIUS HAAST, Ph.D., F.R.S.

[*Read before the Philosophical Institute of Canterbury, June 2, 1869.*]

THROUGH the courtesy of Mr. J. Hood, I have been allowed to inspect, and study, the numerous Saurian remains obtained by him in the Waipara, and now on their way to Europe; and our member, my friend, Mr. T. D. Triphook, at my request, has kindly made a drawing, in natural size, of the principal pieces in that collection, which includes the greater part of a large Saurian head, a truly unique specimen. I also made drawings, and took measurements, of all the more important specimens, so that in case the collection should not reach its destination, the information at least, will not be altogether lost to the scientific world. These remains are generally inclosed in large concretions of arenaceous limestone, having the appearance of boulders. Some of these are nearly perfect spheres; they are very hard, and split generally only with great difficulty, and quite in a different direction from what one would expect.

The collection made by Mr. Hood in the Waipara and its tributaries contains bones of all parts of the skeleton, belonging not only to many different specimens, but also to many species, or even genera and orders.

The principal specimen in Mr. Hood's collection, referred to above, consisted of the portions of a large block which had been split in two. On the one side, the upper jaw and portions of the skull are preserved; on the other, portion of the lower jaw, of which a fragment is exposed on the larger slab. Judging from the size of these remarkable remains, the skull of the animal, to which they belonged, must have been 3 to 3½ feet long, and, consequently, part of an animal which had a total length of 18 to 20 feet.

The teeth, of an oblong form, are from ¾ to 1½ inches long, the dentine being intensely black, and marked by numerous fine longitudinal grooves.

Professor Owen's description (p. 301) of the dentition of the Crocodilians, is as follows:—"The teeth of both the existing and extinct Crocodilian reptiles

consist of a body of compact dentine, forming a crown covered by a coat of enamel, and a root invested by a moderately-thick layer of cement. One root slightly enlarges, or maintains the same breadth to its base, which is deeply excavated by a conical pulp cavity, extending into the crown, and is commonly either perforated or notched at its concave or inner side."

You will observe that the same characteristic features occur also in the teeth of the skull under review :—

The crown covered with dentine, ceases about a quarter of an inch from the jaws, the lower part of the cement forming a well defined line running parallel with the jaw bone.

Mr. Triphook has given to the root of the teeth a darker tint, in his drawing, than exists in the original, where it has almost the same colour as the stone in which it is embedded. Only a slight rise on the surface of the stone indicates where the more perishable lower parts of the teeth were situated.

It is scarcely necessary for me to observe that I am labouring under great difficulties, in having no library of scientific books at my command to refer to, so as to be able to ascertain if similar Saurian remains have been discovered anywhere else, and I may add, that, generally, books of that nature are too costly for individuals to purchase. However, from the data at my command, I may state that the skull under review belongs to an animal of the sub-order *Crocodilia*, called *Amphicœlia* by Professor Owen, and which includes, among others, the genera Teleosaurus and Mystriosaurus.

This sub-order is called Amphicœlia (capped on both ends) from the peculiar character of the vertebræ, the vertebral body being concave on both sides ; they, therefore, differ greatly from the existing Crocodilians, which have a much more perfect arrangement of the vertebral column, and of which I shall speak in the sequel. The Amphicœlia, in respect to the vertebral body, have therefore a more fish-like character than the existing crocodiles.

The same eminent comparative anatomist states, that the vertebral surfaces of these Crocodilians were slightly concave, in order to enable them to make greater progress through the water ; and that the hind limbs were therefore relatively stronger than the fore limbs.

From the nature of the deposits in which the remains of the Amphicœlia are found, we must conclude that they were marine animals.

The numerous vertebræ in the collection of Mr. Hood are,—with the exception of one, of which I shall afterwards speak,—all slightly bi-concave, and therefore agree with the Teleosaurian character. Amongst them are fourteen larger ones, still connected, which, in the average, are 2¼ inches long, by 4 inches high ; over them, and in a reversed position, lie five caudal vertebræ, very long and slender ; also a great many other bi-concave vertebræ were found, which are very remarkable, as being nearly twice as broad as high, some of them are 3 inches broad, and 1¾ inches high.

As far as I know from all the Saurians which have been described, only Plesiosaurus, and Pliosaurus in a minor degree, have this characteristic feature.

Mr. Hood, some ten years ago, took, from the same locality, a collection of Saurian bones to England, which were described by Professor Owen as *Plesiosaurus australis.** Unfortunately, I have never had an opportunity of

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* The specimens referred to "consisted of two vertebral bodies or centrums, ribs, and portions of the two coracoids of the same individual, all in the usual petrified condition of Oolitic fossils. Their matrix was a bluish-grey clay-stone, effervescing with acid ; the largest mass contained impressions of parts of the arch and of the transverse processes of nine dorsal vertebræ, and of ten ribs of the right side. Portions of five of the right diapophyses and of six of the ribs remained in this matrix. The bones had a ferruginous

seeing his description, so that I do not know how far it agrees with the bones in the present collection.

One of the characteristic features of the vertebral body of Plesiosaurus, is, according to the best Palæontological authorities, that it is either slightly concave, or almost flat, with the middle of such cavity slightly convex.

Amongst the numerous vertebræ collected this autumn by Mr. Hood, none could be identified by me which possessed these peculiar characteristics on their terminal articular surfaces.

We possess, however, in our own collection, and now lying before you, one dorsal vertebra which answers the above description.

As before observed, the Amphicœlia had well-developed limbs, and I was therefore anxious to find bones belonging to the species of which the skull had been discovered. There were several good-sized bones which answer perfectly the description given by various authors, and I was therefore enabled to identify all the principal bones, such as the femur, tibia, and fibula, of the hind limbs, as well as humerus, ulna, and radius, of the fore limbs; some toe phalanges were also amongst them, of which the largest is 1½ inches broad, by 2½ inches long, and which, consequently, must have belonged to a large animal. I have just observed that no vertebræ of Plesiosaurus have apparently been found by Mr. Hood; as you are aware, a true Enaliosaurian, or Sea-lizard, possesses four fins, or paddles, instead of four, more or less developed legs. The principal bones of the hind and fore limbs of these Enaliosaurians were, the humerus and femur, both of which had a convex head, sub-cylindrical at its proximal end, and gradually becoming flattened and expanded at its distal end.

Several fine specimens, some of them 10 inches long, 3½ inches in diameter at their proximal or upper end, and 6¼ inches at their lower or distal end, are in Mr. Hood's collection, also several other bones of the lower portions of the four extremities; the metacarpal phalange bones are well represented. However, I must here add, that some of these bones might have belonged to an Ichthyosaurus, or the huge Enaliosaurus, which resembled, more than any other, a whale or fish.

There are also several fine specimens of the sternal and pelvic apparatus, and ribs; amongst them, I show you here a portion of a humerus of, probably, Plesiosaurus, found some time ago by Mr. E. Sealey, and presented by him to the Museum. Also the lower or distal end of a femur, from the same locality. I also offer to your inspection, portion of a metacarpal, and some phalangeal bones, of which the paddle of Plesiosaurus was composed.

Consequently, it seems, that in the beds, under review, Saurians of different ages, and belonging to different genera and orders, existed in our seas, in times gone by, and in what may be considered of at least cretaceous age, although I say so with some diffidence, and wish to observe that a great deal more work has to be done before the question of the age of our middle and younger sedimentary rocks can be determined. Here are the different geological sections of the Waipara beds, on them, you will observe, that the beds in which those Saurians are found, underlie, uncomformably, the

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tint, contrasting with the matrix, as is commonly the case with specimens imbedded in the Oxfordian or Liassic clays."

"The shape and mode of articulation of the cervical and dorsal ribs, the shape and proportions of the coracoids concur with the more decisive evidence of the vertebræ in attesting the Plesiosauroid character of these New Zealand fossils, and, pending the discovery of the teeth, the author provisionally referred them to a species for which he proposed the name of *Plesiosaurus australis*, The specimens had been presented by Mr. Hood to the British Museum." Owen. "Report of British Association," Manchester, 1861. Transactions, p.p. 122-3.—Ed.

so-called Weka Pass beds. When, some years ago (in 1864), I paid a flying visit to the Waipara, I concluded, from a hurried examination, that the beds, under review, were lying between the Weka Pass beds and the Red crag beds, which form the Deans, but Dr Hector, who visited the locality some time afterwards, pointed out to me, that according to his views, the beds in question, were underlying unconformably. Since then, I have examined, carefully, this and some other localities, in which similar formations occur, and have found that Dr. Hector's views are correct, and that to him, therefore, belongs the credit of having first pointed out the true position of these beds, a fact which is of the highest importance in New Zealand geology.*

The large Ostrea beds are thus very important as showing us the exact position of the upper and lower beds.

To show only one instance of the importance of this fact, I may point out that the quartzose trachytes of the Malvern Hills, which, hitherto, we considered to be old tertiary, must now be classified as of secondary age, and the name quartzose porphyries will be more appropriate to them. The importance of the subject under review is, I trust, sufficient excuse for my transgression. In the small seams of brown coal and shale, which occur in the same region, has been found the only vertebra of a procœlian character.

The term procœlian (hollow in front) has been selected by Professor Owen for vertebræ, of which the front surface is concave, and the hind one convex.

The centre of the vertebra, in question, is 3 inches high, and 3½ inches broad, of course without reckoning the neural arch and the pleurapophyses, and consequently belongs to an animal of considerable age, having, doubtless, the same habits as the crocodiles of the present day. There was also, what I consider to be, the distal or lower portion of the femur, which, judging from the articulation, evidently had some affinities with terrestrial remains, such as the Iguanodon a herbivorous terrestrial reptile, of enormous size, and living in the Northern Hemisphere, in the wealden and greensand (cretaceous) period. The procœlian remains were first found in the Northern Hemisphere, both in America and Europe, in Eocene tertiary strata, and principally in fresh-water beds; and I may here add that the procœlian vertebræ of the Waipara have also been discovered in lignite beds, which are either of fresh-water or littoral origin.

I am well aware that these notes are very imperfect, owing to the short time allowed to me to study the interesting remains under review, and as I had not the necessary works for comparison and reference, I have, therefore, to crave your indulgence.

I may, finally, be allowed to express my sincere regret, that such a valuable collection has left the Province and New Zealand; however, the fact that they will come, doubtless, into the hands of Professor Owen, is some slight satisfaction to me, because we can, with certainty, expect that that illustrious comparative anatomist, will afford us a classical description of them, which will form the basis of reference and work for all future New Zealand Palæontologists.

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* See "Geological Report," 1868-9, p. xi.—Ed.

V.—MISCELLANEOUS.

Art. XLV.—*Preliminary notice of a* Ziphid Whale, *probably* Berardius Arnuxii, *stranded on the* 16*th of December*, 1868, *on the sea beach, near New Brighton, Canterbury.** By Julius Haast, Ph.D., F.R.S.

[*Read before the Philosophical Institute of Canterbury, May* 5, 1869.]

Towards the latter part of December, last year, it was stated that a whale had been stranded on the sea beach, near the mouth of the Avon. Unfortunately, the notice reached me too late to enable me to see the body in its fresh state, and when I went to the sea beach the blubber had been cut off nearly a week, and the animal was already in such an advanced state of putrefaction, that the external appearance was greatly destroyed. Before entering into a description of its affinities and peculiarities, I may be allowed to offer a few observations on its capture.

Mr. William Walker, a fisherman, living near the mouth of the Avon, one mile and a half below New Brighton, observed, on the 16th of December, early in the morning, that a huge animal was in the surf, making the most strenuous efforts to return to deeper water. The fisherman had only a large sheath knife with him, with which he stabbed it several times, making it bleed very freely. Each time when the surf reached it, it threw out a large quantity of water and sand from its blowers, like a fountain; at the same time it moved its tail with such vehemence, that it threw its captor several times, when he came too near it. Seeing that he could not manage the large animal by himself, he returned home to fetch a rope, a larger knife, and assistance. After having, with some trouble, placed the rope round the tail, and fastened it securely to the stump of a tree on the beach, he inflicted with the large knife some deep wounds, from which the blood ran copiously; but the animal, notwithstanding this great loss of blood, still lived for fourteen hours. The fisherman also put a large stick several times into its mouth, which, to use his own words, made the whale "bellow like a bull."

A very interesting fact may be deduced from the observations of Mrs. Walker, who accompanied her husband on the second trip. She told her husband that each time he put the stick into the whale's mouth, she could see several large teeth in front of its lower jaw, which, however, were not observed by anybody else, and the existence of which was only revealed when the skull was cleaned, when, in front of the lower jaw, two large triangular and moveable teeth on each side became exposed. It thus seems that the Ziphid Whales, when defending themselves from their enemies, or attacking their prey, have the power to protrude these four teeth at will. Such a hypothesis gains still more in probability, when we consider the nature of the principal food of the animal, which, judging from the contents of its stomach, seems to consist almost exclusively of the common sea-spider, or Octopus—a cephalopod which, as in the Northern hemisphere, does not seem to be very numerous along the coast. In the stomach of the whale in question there was about half a bushel of the horny beaks of this cephalopod, which were nearly all of the same size. It would be rather difficult for any whale to obtain possession

* This paper was received too late for insertion in its proper place, in Section I., Natural History.—Ed.

of such an agile animal as the Octopus, had not nature furnished the former with the means of taking good hold of it. It is interesting that the allied genera Ziphius and Hyperoodon, of the Northern hemisphere, feed also on similar species of cuttle-fish, as I learn from a paper of Dr. J. E. Gray, of the British Museum ("Proceedings Zoological Society, 1868," p. 422). Also, the Sperm Whales are said to feed almost exclusively upon the same voracious animal, which, by its agility and organization, is so well adapted to make great havoc amongst the smaller inhabitants of the sea. And, as Dr. Gray justly observes, it proves, at the same time, that these cephalopods, although apparently of rare occurrence, must in many localities be very numerous, as it would otherwise be impossible to understand how they could furnish those huge whales with sufficient food.

When I proceeded to the beach, the animal was still lying in the surf, partly covered by sand, but still intact. I measured its length exactly, and found it to be 30 feet 6 inches, from the tip of the nose to the end of the lobes of the tail. The colour of the whole animal was of a deep velvety black, with the exception of the lower portion of the belly, which had a greyish colour. The tail was 6 feet 6 inches broad, and had the usual two falcate lobes. The dorsal fins were situated near the neck, a little above the middle of the body, and were 17 inches broad, and 19 inches long. They had a triangular form, and one of them was buried in the sand when I saw the animal first. The dorsal fin was unfortunately destroyed when I first inspected the whale, so that I cannot describe its form and position from my own observations; but Mr. Walker told me that it was small, had the usual falcate form, and was situated not far from the tail.

I may here observe, that from the form of the skull and some other characteristics, it appears evident that this whale is the *Berardius Arnuxii* of Duvernoy, of which a specimen was caught in 1846, in Akaroa harbour, the skull of which, of a length of four feet, is at present in the Imperial Museum, in Paris. The animal to which it belonged is described as having been thirty-two feet long, and possessing a large dorsal fin, with a large boss or hump in front of it. As putrefaction and the cutting off of the blubber had greatly changed the outlines of the animal, I could not observe whether it possessed the larger boss in front. Mr. Walker did not speak of it when he gave me a description of the animal as it appeared when captured. However, as the figure of the skull, as given by Duvernoy in the "Annales des Sciences Naturelles," and copied into Dr. Gray's "British Museum Catalogue of Seals and Whales," is identical with that of our own specimen, I do not hesitate to state that both belong to the same species. It also seems to me that this whale is very local, probably inhabiting only the coast of New Zealand, and perhaps the regions south of it, because, as far as I can find, it has never been observed elsewhere. It has without doubt not been met with on the coasts of Australia, or it would not have passed unnoticed, as, amongst others, the energetic director of the Australian Museum, Gerh. Krefft, F.L.S., has not observed it. I may here state that the form of the skull is very peculiar, reminding one strongly of that of a dolphin.

There seems to be nothing known of this peculiar whale, except its external appearance and its skull, and it is, therefore, a matter of congratulation to us, that we shall be able to supply all the details of its osteological characteristics, which are peculiar in many respects.

The specimen in our possession was evidently a young animal, because all the disc-like epiphyses of the vertebræ are still detached. The same is the case with the epiphyses of the limb-bones, which are not yet united with them; also, the sutures of the cranium are not yet obliterated. The beginning of coalescence is, however, to be observed in the seven cervical vertebræ, of which

the three first are already anchylosed, the two first completely, and the second and third only partially, as the neural arches and transverse processes are not yet united in one bone. In the allied Hyperoodon all the cervical vertebræ are coalesced, and it is therefore possible that when Berardius is in an adult state, the same will take place. The Ziphius has six cervical vertebræ separate, and it will therefore be necessary to examine very carefully into the character of the uncoalesced vertebræ of our skeleton before giving a decided opinion upon the subject. It possesses ten dorsal vertebræ, in common with *Ziphius Sowerbiensis;* the hyperoodont whales have nine, and the dolphins thirteen to fifteen. I have not yet been able to count and examine the lumbar and caudal vertebræ, as the animal was in such a state of putrefaction, that after cleaning the bones as well as possible, and leaving often a great portion of the vertebral column together, we put them at once to macerate. We obtained only one of the small pelvic bones, the other having probably been washed away by the surf; it might, however, owing to its diminutive size and sticking loosely in the flesh, easily have been overlooked. As soon as the bones are clean, so that I can examine them, I shall offer a few more observations upon the osteology of this remarkable animal, for the complete skeleton of which, the Canterbury Museum is indebted to the members of the Philosophical Institute, without whose pecuniary assistance I should have been unable to secure it for the Provincial collections.

ART XLVI.—*On* UNIVERSITY EDUCATION, *as adapted to the circumstances and prospects of the Colony of New Zealand.* By CHARLES FRASER, M.A., F.G.S.

[*Read before the Philosophical Institute of Canterbury, June* 2, 1869.]

MUCH useless discussion may be avoided, and our progress greatly facilitated, if from the very outset, we come to a distinct understanding upon the following three points:—1. What is a University? 2. What should be its distinctive objects in the colony? 3. How far may we expect to carry out any good system within the next few years?

(1.) In regard to the first question,—What is a University? the two oldest Universities in Europe furnish us with somewhat opposite definitions. The University of Bologna was a Corporation of Students; the University of Paris was a Corporation of Teachers. It would probably be nearer our mark to combine the two, and to contemplate the establishment of a Corporation of Teachers, Graduates, and Students, under the presidency of certain officers appointed by the Government. Of course the privileges and powers of the three classes named would be different; but it seems to me that all ought to have their share of influence in the conduct of business.

(2.) The distinctive objects of a Colonial University cannot be better described than in the words of the charter, granted by Her Majesty to the University of London:—"the advancement of religion and morality, and the promotion of useful knowledge, by holding forth to all classes of Her Majesty's subjects, without any distinction whatsoever, an encouragement for pursuing a regular and liberal course of education, by offering to persons who desire to prosecute or complete their studies such facilities, and conferring on them such distinctions and rewards as may incline them to persevere in their laudable pursuits; and for the purpose of ascertaining by means of examination, the persons who have acquired proficiency in literature, science, and art, by the pursuit of such course of education, and of rewarding them by academical degrees, as evidence of their respective attainments and marks of honor proportioned thereunto." In other words, University Education in the colony

ought to contemplate not the instruction of the members of a particular class of society in the higher branches; but the providing of the means of the best and highest possible education for as many as possible of all classes of society. This was the original object of the older Universities of Europe, and we cannot do better than return to it.

(3.) The third question concerns the immediately practical nature of any proposed scheme. Now, it will not be expected that the colony should send forth, at once, a completely equipped professoriate, prepared, Minerva-like, for all requisite undertakings. But it is possible to inaugurate a good system, to establish a certain portion of it, and to make provision for the whole. Our circumstances are peculiarly favourable to such a gradual method of procedure. The youth of the colony is not prepared to avail itself of a full course, but it may be greatly benefitted by provision being made for establishing certain branches of instruction without delay. And this is further peculiarly the time when reserves can be made from the public lands of the various Provinces as permanent endowments. These two points seem of themselves a sufficient vindication of any attempt, such as the present, to draw public attention to the subject.

We will first of all address ourselves to a brief sketch of the University system.

Many of the difficulties which have often beset public questions in New Zealand, might be avoided in this case, by distributing the various colleges constituting the University, instead of congregating them all in one place. Let us imagine for a moment the effect which would be produced, if the several colleges of Oxford were distributed among so many counties of England, say in Yorkshire, Lancashire, Lincolnshire, Devonshire, Hampshire; and if their principal men were assembled at some central point such as Oxford, or occasionally moved from place to place, for conducting examinations, granting degrees, and for other University purposes. Such is the scheme which seems best fitted for this colony. Let each province be left to establish and endow its own college, appoint its own professors, and fix its own course of instruction, subject to certain general instructions and regulations as prescribed by the General (Colonial) Government. Let there be a general council of the University, elected for the most part by the graduates of the colleges, but with one or two members elected by the undergraduates, or students, of each college, and with a permanent president and vice-president. To this council would belong the power of initiating such changes as from time to time might require to be effected in the laws and government of the University, and also of deciding upon such questions of dispute as might arise from time to time in any of the colleges, between the professors, or between professors, graduates, and students.

Let there further be a senate, composed of a chancellor, vice-chancellor, a certain proportion of the professors from each college, and a certain number appointed by the votes of the council. To this body let there be entrusted the necessary powers for making examinations, granting degrees, and similar purposes.

A quinquennial visitation of the colleges and the senate, conducted by a board specially appointed for that purpose, and named by the council, would tend greatly to preserve and promote healthy and vigorous life throughout the whole establishment.

Into the question of the appointment of professors it is unnecessary to enter; especially, as there is no reason why the same exact method should be observed in every college. But as a general rule it might be well ultimately to place a considerable, if not the chief, part of the power in the hands of the graduates.

It remains for us to consider the subjects and the method of instruction.

I. In discussing the subjects to be taught, the first and most important topic that meets us is the place to be accorded to languages, and especially to the languages of ancient Greece and Rome. No one who has a desire to promote the highest culture in himself or others, will seek to exclude these languages from a full system of education. Besides the arguments which are usually adduced in their favour, there are two which appear to be of pre-eminent authority. One of these is, that the civilization of these two countries is the only one which we can definitely trace from its early dawn, throughout a splendid though varied career, right onward to its final disappearance amid the clouds of luxury, depravity, and barbarian invasion. The history of no other nations presents us with an account so full in all its details, so complete as a whole, of the growth and decay of the principles of art, philosophy, law, and political action, diffused throughout whole generations of a social system, and expiring with it: and the world, it is to be hoped, will never see the like again. The other main argument in favour of the classic tongues is found in the important use which is made of them, as forming together a sort of common language for scientific men, and affording the basis of one common scientific nomenclature. From the countless names of the ever-increasing lists of botany, upwards, to the words which describe the newest and most important discoveries, such as the electric telegraph, palæontology, seismology and the wonders of the solar spectrum, we are indebted to Greek and Latin for terms which are universally intelligible among scientific men of different countries, and which interfere with the genius and tendencies of no living language.

The admission of the classic languages, then, into every system of education, which aims at either completeness or high culture, may be regarded as placed beyond all question. But the grounds on which they are admitted, and the kind of study of which they will form the objects, may be said to have undergone a complete revolution. Languages may be acquired and mastered, either on account of their usefulness as instruments of thought, and of the literary and philosophic treasures which are found in them, or as objects of interest in themselves, means of disciplining the mind, and permanent, crystallized records (I know not how otherwise I can express the idea) of a certain cast of national life and thought. For the sake of this second class of objects, it may be most desirable and necessary that the minutiæ of a language be completely mastered, and the power of composing both prose and verse in it be fully acquired. But Greek and Latin have no longer the exclusive claims to be so studied, which they once possessed.

The science of language in general, and of universal grammar, as illustrated in the works of Bopp and Max Müller, at once supplants them, and includes them as a part of a more comprehensive scheme; while the Sanscrit of India, and the Anglo-Saxon from which our own language is derived, have as certain, though not as great, a claim upon our attention.

What knowledge may be required of the minutiæ of idiomatic Greek and Latin, ought therefore to be relegated to the preparatory schools; while the University ought in its several colleges to assume this knowledge as acquired, and instead of professorships for instruction in Latin phrases, Greek dialects, and metrical niceties, should establish professorships of the combined study of the history and languages of ancient Greece and Rome. The works of Grote, Stuart Mill, and Rawlinson, indicate sufficiently what the course of study might be in this department.

This short explanation may perhaps have paved the way for the account of such a course of study as ought to be pursued.

But here two principles require to be steadily kept in view, and used to

guide us in regard to the order in which the different branches of study ought to be taken up :—

1. Those studies which are most difficult, either from their nature or by reason of the complexity of their objects, ought to be reserved to the last.

2. The natural progress of development observed by the mental faculties themselves, ought to be followed as far as possible.

As a general rule, then, languages would come first in order, then sciences of observation (or natural history in its various branches); next the material sciences of induction and deduction, or those sciences which examine the changes which take place in material bodies, and the forces by which those are produced, such as the departments of natural philosophy and chemistry. At the same time, mathematics, or the science of abstract number and quantity, ought to be pursued.

Thereafter would come mental and moral science, and lastly social science in its two great departments of history and political economy.

According to these views the staff of professors in each college, which attempted to give a complete scheme of education, would take up the following subjects in their order :—

I. The history and languages of Greece and Rome.

II. Languages and universal grammar.

Under these two heads it is almost needless to say that a very great variety would be afforded both as to subjects and mode of treatment. Along with a general and rapid view of the whole field, special authors would be selected in the first case, and special languages or families of languages in the second.

III. Natural history, in its various branches of mineralogy, geology, hydrology, meteorology, botany, and zoology.

IV. Mathematics.

V. Natural philosophy and chemistry, including under the first term somatology, or the doctrine of the general properties of bodies; mechanical philosophy, or the dynamics and statics of solid, liquid, and gaseous bodies; electricity and magnetism, optics, astronomy.

VI. Mental and moral philosophy, or psychology and ethics.

VII. English language and literature.

VIII. Logic and rhetoric.

IX. Sociology, in the historic and dogmatic form, that is, as modern history and political economy, and jurisprudence. (Hallam, Mill, Austin).

It will be observed that according to this arrangement we have the various branches of study set in distinct groups, and according to a definite, and, it would seem, a natural plan.

We take first of all languages, the great instruments of thought. Then we turn to physical science and mathematics, in their several divisions, when the mind is exercised and assisted by the sensible forms or representations of things.

Thereafter the mind is directed to a much higher, but much more difficult study, the study of its own faculties and laws.

Following these come what may be termed the practical application and realization of the principles hitherto acquired, in a consideration of the English language and literature, the methods of reasoning and persuasion, and the historical and formal discussion of the great problems of life.

The question which naturally suggests itself on review of these departments of study is, "How far, and to what extent, may we contemplate the establishment of such a number of professorships, as might, even in a few years, afford to the youth of this province the advantages of, at least, a portion of this course?" It is very evident that, in time, the number of these

professorships would require to be greatly increased, but meanwhile very considerable benefit would result from the establishment of even a few of them.

At present the study of languages is so far provided for, that we might rather look to the physical sciences, as claiming first attention; and it so happens that this accords well with the necessities and the demands of colonial life.

Natural history is the first department which ought to be provided for, and then mathematics, natural philosophy, and chemistry. English language and literature might be taught in alternate years with logic and rhetoric, by the same professor. Modern history and political economy would form a fourth department. And to these would be added, from time to time, the remaining branches, as necessity for them arose, and the means were provided.

The suggestion which was thrown out during the last session of the General Assembly, that lectureships might, in the meanwhile, be established, at a moderate cost and with very great advantage, seems still to be worthy of consideration, and within our immediate reach. By these means our own Museum would form the nucleus of an important institution, which might gradually develope into a complete college, and constitute no mean branch of a Colonial University.

I have purposely avoided any reference, at present, to the question of professional education, in law, medicine, and civil engineering: but it is apparent that the course now sketched out would be of very material, direct benefit to the students of these departments.

The method of instruction is a wide and quite distinct subject, requiring to be considered with regard to the peculiarities of each branch of knowledge. This may form the subject of a second paper, if leisure and the other engagements of the Institute permit.

ART. XLVII.—*On the* GENERAL PRINCIPLES OF AN EDUCATION SCHEME *for New Zealand.* By W. S. HAMILTON, Mathematical Master, Wellington College and Grammar School.

[*Author's Abstract of Paper read before the Wellington Philosophical Society, November* 13, 1869.]

THIS paper first reviews the position of the question by examining existing circumstances, and enumerates the difficulties surrounding the subject as follows: "The mixed nature of society,—people of different countries and creeds; of different ideas of the object and character of education, and of different degrees of education and refinement;—the population being scattered;—the difficulty of obtaining trained teachers;—the high price of labour tempting parents to withdraw their children from school at an early age, and the teachers to abandon their professions for more lucrative pursuits;—the absence of a standard for teachers to work up to;—the little interest taken in the teacher's labours, by a heterogeneous and restless population;—the absence of inducements to study on the part of the pupils, and the difficulty of procuring funds in the absence of foundations and endowments."

"These complications deter statesmen from considering the subject till necessity compels; when the educational system of some larger or differently circumstanced community is hastily adopted, without the necessary material on the ground for the construction of the fabric. Disappointment follows, and the result often is, the entire neglect of education for a time." The provinces of Auckland, Wellington, and Southland are cited as examples of this neglect; while on the other hand Nelson is referred to as an example of attempting to impart a higher education than is possible or profitable for a young colony.

The proposed Otago University scheme is referred to the same error. The *kind* of education, as well as the *amount* suitable to the colony, is thus remarked on :—

"The circumstances of a colony of men of many different creeds forbid the introduction of religious teaching in national schools, however advantageous such an element in education might be, while the requirements of a new country demand that its education should be of a thoroughly practical character. When superior schools become necessary, science and modern language will, no doubt, form a far more profitable field of exercise than ancient literature. The few literary and professional men required will, for a considerable time to come, be more advantageously imported from older countries; in point of fact there is always an over-supply of these ready to hand, while intelligent farmers and miners, and enterprising tradesmen and mechanics, trained to the make-shift necessities of a new country, are more wanted, and must be trained on the spot amidst these conditions. To place these classes in the most favourable position to become thus valuable to the country, should be the aim of the kind of education afforded by Government."

On the working of any proposed system, the point of primary importance is stated to be the *personel* of the teacher. To obtain trained teachers of character and ability, should be the end aimed at in every provision. The system of licensing teachers, as practised in France, Holland, and other countries, is recommended, in order to prevent inexperienced and incompetent men from entering the profession. On the other hand, in order to obtain a sufficient supply, permanency of appointment, and sufficient inducement, are necessary provisions. To this end grants of land, or school reserves of sufficient size, are recommended, along with a moderate fixed salary from Government. Under the head of affording a standard for schools to work up to, and inducements for young men to study, the following occurs, regarding civil service examinations :—

"In Victoria these examinations do excellent service in stimulating education; the certificates of the board are received by business houses, as evidence of a certain amount of education, as also of habits of industry and application at school; and young men take a pride in showing that they are not behind others in these qualities. It is thus not the actual appointments into the civil service which give these certificates a value, but the recognition of them by other interests. A little management on the part of our Government, and a little public spirit on the part of our leading interests, could make our Civil Service Act sub-serve the same useful purpose. * * This would be a simple means of supplying a standard of comparison for schools, and of exciting their emulation. The Government would also by this means have it in its power, by determining the subjects of examination, to prescribe to schools the subjects of study, and to a great extent the amount."

It is further suggested that the General Government should initiate a scheme, simple at first, by the appointment of a Secretary of Education, whose duty it would be to make provision for education in those provinces, which neglect this duty, and that, at the expense of such provinces; while the provinces which are doing well in this respect, should be left alone, should they wish it. The General Government would thus make sure that no part of the colony was left uncared for in the matter of education; and having thus planted a system, it would be growing and perfecting itself, by natural adaptation, to the necessities of the case.

ART. XLVIII.—*On the River Systems of the south portion of the Province of Wellington.* By J. T. STEWART.

(With Map.)

[*Read before the Wellington Philosophical Society, August* 14, 1869.]

THE accompanying map is of a part of the Province of Wellington, and shows the main rivers, with some of the principal lines of watershed, and the ranges of hills. This paper is explanatory of it, and refers particularly to some of the river systems.

The portion shewn on the map is from the area drained by the Manawatu on the north, and extending southward to the extremity of the province.

Of the other portion of the province lying to the north of this, I have not sufficient data to represent its rivers on the map, and consequently do not attempt to describe them; although they present many important and interesting features, coming as they do, at least two of them, the Whanganui and the Wangaehu, from the centre of the island, near Tongariro and Ruapehu.

The approximate areas of the portion of the island represented on the map may be stated thus :—

Area of part of the province shown, 5100 square miles, or 3,264,000 acres, —nearly half the area of the province. Area of part of Hawke's Bay province included, as drained by the Manawatu, 320 square miles, or 204,800 acres. Thus making the whole area treated of, 5420 square miles, or 3,468,800 acres, or nearly three and a half millions of acres.

Subdividing this we have :—

	SQUARE MILES.	ACRES.
In the Manawatu drainage area . .	1830	1,171,200
In the Ruamahanga, or Wairarapa drainage area	1300	832,000
On the West Coast, from the Manawatu to Paikakariki, drained by the Horowhenua, the Ohau, the Waikawa, the Otaki, the Waikanae, and numerous small streams running directly into the sea	550	352,000
Between Paikakariki and Palliser Bay, including Porirua, and Wellington, by the Hutt, the Wainuiomata, the Orongorongo, and many smaller streams	500	320,000
By rivers on the East Coast, from Palliser Bay to the Whareama .	570	364,800
By the River Whareama and its tributaries	250	160,000
By rivers on the East Coast, from the Whareama to the boundary of the Province, at Waimata, by the Wakataki, the Mataikuna, the Aohanga, the Akitio, and numerous small streams running to the sea directly .	420	268,800
Totals	5420	3,468,800

Of this total area, about 2500 square miles, or 1,600,000 acres are covered with bush or forest, so that little apprehension need be felt at the prospect of

drought being induced in most of our main rivers by the destruction of the bush.

There is more liability to such a contingency occurring in the smaller streams, and perhaps in the East Coast rivers, and in some of the Wairarapa rivers, where the country is more scantily furnished with forest.

I recollect in the dry summer of 1863-4, observing both the Whareama and the Taueru rivers to have nearly ceased running, consisting of a chain of pools connected by a very small run of water between them.

Also the Aohanga river, at a place well inland where it falls perpendicularly over a ledge of overhanging rock for a height of about sixty feet, seemed at that time a mere thread of water, which the gusts of wind at times dissipated into spray before it reached the river bed below.

On such rivers the preservation of the bush about their upper courses, and on their feeders, becomes an object of importance.

It will thus be seen, from the table of areas, that the Manawatu and the Ruamahanga are the most extensive and important river systems in the part of the province under consideration, yet the areas drained by them differ much in character, and the rainfall over them is affected by different meteorological influences.

The Ruamahanga, or Wairarapa area, has much more open country in it than the other, and its supply is derived from the rain falling to the eastward, only, of the main dividing range of the Tararua.

It gets most of its water directly from the eastern side of this range, by the head of the Ruamahanga itself, by the Waipoua, the Waingawa, the Waiohine, and the Tauherenikau, which latter falls into the lake.

It also gets the drainage from the eastern side of the Rimutaka range, by many streams chiefly discharging into the lake.

By the Tauheru and its tributaries it drains a large extent of elevated hilly land, more or less open, lying to the N.E. of the Wairarapa valley.

By the Huangarua, the Dry river, the Rahohuru, the Turanganui, and many small streams, it drains the more open country lying on the west side of the watershed between the lower part of the Wairarapa valley and the East Coast. The melting of the snow in summer affects it by the rivers running from the Tararua mountains, and this probably to a greater extent than occurs in the Manawatu area.

One noticeable feature in the Ruamahanga is, that it discharges itself, in the first place, into the Wairarapa lake, and flows out of it again not far from where it enters, with the addition of the waters collected in the lake by streams falling into it directly. The river, after a course of a few miles, flows into the lower or smaller lake, which is divided from Palliser Bay by a narrow belt of beach, through which the river flows into the sea by a channel which sometimes is closed entirely by the action of the heavy surf in Palliser Bay, and then the water being dammed back fills the lakes, and floods a large area of low marshy land about their margins, until the accumulated water again forces a passage into the sea, when the lakes subside and relieve the adjoining low levels of the surplus water.

The nature of the passage into the sea of this river has withheld from the Wairarapa the advantages of a navigable river, notwithstanding the large area drained, and the numerous and large tributaries of the Ruamahanga.

The state of this area has been much modified by its long occupation by European settlers; and the substitution of grasses for the growth of bush, fern, and scrub, to a large extent, must affect the rapidity with which the rainfall finds its way to the streams and rivers.

The area drained by the Manawatu system of rivers, on the other hand, is still nearly in a state of nature, except what change the native occupants

have affected, which would not seem to be much, in regard to any effect produced on the subject now under consideration.

This river and its tributaries present several interesting features.

The main river itself penetrates, by a narrow rocky gorge of picturesque scenery, the main dividing range of this part of the island, and separates it into the Ruahine and the Tararua mountains.

In this gorge there occur several reaches of still, deep water, and as the view is shut in at both ends by the winding course, the traveller seems to float in his canoe in a rock-bound mountain lake, with grey lichened cliffs, overhung with ferns and shrubs, and steep wooded slopes, rising above them. These quiet reaches are separated by dangerous rapids, full of boulders and rocks.

Both above and below the gorge the country is lower, and the character of the river is a rapid course over wide shingle beds, and this makes the change into the gorge more striking.

This river takes the rainfall of both sides of the southern end of the Ruahine range; for twenty-five miles on the east side, by the portion of the Manawatu proper, which runs in the Province of Hawke's Bay; and for thirty miles on the west side by the River Puhangina, which has a course almost parallel with the range, and joins the Manawatu only some one and a half miles to the west side of the gorge; and also by the sources of the Oroua to the north of the head of the Puhangina.

The Manawatu also takes the rainfall of both sides of the northern end of the Tararua range; for thirty miles on the east side by the Mongahao river, which runs almost parallel to the range, and joins the Manawatu only a mile or two to the east of the gorge, and also by streams falling into the Forty-mile bush rivers from the hills south of the head of the Mongahao; and for twenty miles of the west side of the range, by the Tokomaru river, and the Kahuterawa, and other large streams falling into the Manawatu on its southern bank. It also gets the drainage of the table-land of the Forty-mile bush, by the Makakahi, Mangatainoko, and other streams falling into the Teraumea,—which joins the Manawatu to the east of the gorge;—and by the Teraumea river, which rises on the east side of the Puketoi range, it gets the rain falling on both sides of the southern end of the Puketoi range; and by the Waitawhiti, the Ihuraua, and other streams it drains a part of the high lands adjoining the heads of the Whareama and the Taueru rivers, which both flow to the eastward part of the province.

By the numerous rivers and streams flowing into the Oroua from both sides, into the Puhangina from the west, and into the north side of the Manawatu itself to the west of the gorge, the rainfall over an extensive flat and table country between the Ruahine range and the sea coast also finds its way to the sea by the Manawatu.

Drawing its supply from such an extensive area, exposed to so much variety of climatic influences, it would seem that we need not expect all its tributaries to be flooded at one time; as the north-west rains will affect the Oroua, Puhangina, and streams to the west of the dividing range, while the south-east rains will flood the rivers on the eastern side.

The south-east or south-west rains, however, produce the heaviest floods, as the rain-drift flies along the line of the main range, and supplies both slopes at once, as well as probably falling more copiously on the area to the east of the range, and on the southern end of the Puketoi mountains, while the north-west rains striking more transversely to the line of the main range, probably fall more heavily on the western slopes than on the eastern.

The northern end of the Tararua, falling in height as it approaches the gorge, does not contribute much water from summer melting of snow, but

some supply of this nature is probably derived from the Ruahine at the sources of the Oroua river.

The whole area drained by the Manawatu being 1,171,200 acres, we find the very large proportion of over 1,000,000 acres to be bush-covered, also there is much flat country, so floods neither rise nor run off so quickly as in an open country. The dense vegetation of the bush retains a large quantity of the rainfall, and the ranges themselves are chiefly bush, and not very precipitous in general character.

For instance, on the Tirohanga hill-track, from the Manawatu to the Forty-mile bush, passing over the Tararua range, after attaining on elevation of about 1200 feet, we find nearly three miles flat before the ascent to the summit is made; several streams flow through this flat, and the ground has a thick, spongy stratum on the surface of roots, moss, and soil.

Similar comparatively level tracts, no doubt, exist at many places on the hills at considerable elevations; and thus the water falling on them by no means necessarily finds its way rapidly to the lower levels and the main river bed. From these causes more water must be taken away by absorption and evaporation, than at first might be supposed.

One feature in the course of the Manawatu, as of other similar rivers, is the numerous old water-courses abandoned by the river, and now forming semicircular shaped lagoons of uniform width in the flat bush country.

These are found at intervals in a belt of half a mile to a mile and a half in width, on both sides of the river.

They have formed old river beds, cut through at the neck by the current, and the ends silted up by the deposits brought down in floods. This process still goes on, general extensive bends having been cut off within my own knowledge, as at Raukawa, and near the mouth of the Tokomaru.

A kind of balance is thus probably kept up between the speed and wearing power of the current, and the nature of the soil acted on by it, so that the total length of the river course along its numerous windings, maintains a mean from time to time; the formation of a long bend by the stream eating into the banks at one place, being counterbalanced by the cutting through the neck of a peninsula at another.

Some of these lagoons are over a mile long, and form fine sheets of water. They are mostly filled in heavy freshets, by the water backing up the stream flowing from their lower ends, and they, together with a large extent of low land subject to floods, for some miles above the junction of the Oroua, act as storing reservoirs for some of the surplus waters, as also do two large open swampy tracts whose surface is about the level of high floods,—one on the south side, called Makurerua, of some 15,000 acres, and the other lower down on the north side, called Ohotuiti, of some 7000 acres, and both with many shallow lagoons in their area. These are of rich soil, and when drained, of which they are capable of being, will form important flax-growing and meadow lands.

The large extent of sand and gravel deposits also, no doubt, absorbs and discharges gradually a large part of the rainfall, and of the waters brought down by river floods.

Differing from the Ruamahanga, the Manawatu is navigable for many miles from its entrance, to vessels of six or eight feet draft of water, which the bar at the mouth allows to enter, and the flood tide, when there is no fresh in the river, gives an upward current for fifteen or sixteen miles from the mouth.

The course of the Oroua gives a good section of the land lying to the west of the Ruahine range. For ten or fifteen miles of its lower course, it divides the open sandy country of the coast from the alluvial bush land, and here its

current is not so rapid, and its channel is narrow, muddy, and canal-like. Above this it becomes wider and more rapid, with shingle beds, and the banks show gravel deposits, which increase in height as it is ascended, and in the upper course cliffs of 100 feet to 200 feet high, washed by the river, show horizontal well-marked layers of sand, gravel, and clay, with marine shells. These beds preserve their horizontal position until the spurs of the range are approached, when they show a decided dip to the west, in parts.

About seventy to eighty miles, by the winding course, from its junction with the Manawatu, the Oroua cuts through a spur by a gorge faced by cliffs of rock, about 150 feet high, and nearly perpendicular, and close to here the first hard rock was observed, coming up the course.

The channel here is full of boulders and rocks, and the run is rapid. Looking through this gorge, however, in the direction of the range, the same horizontal strata of sand, gravel, and clay, are again seen in the high river bank; and it is probable the river extends a long way further into the main range, as its volume here seems quite as great as in its lower course, showing, at least, that its main supply comes from the hills surrounding its source in the Ruahine.

I have not attempted to estimate the quantity of water discharged by these rivers, although an approximation might be made from the estimated rainfall over the areas drained, and allowing for absorption and evaporation; yet in the absence of observations on the actual volume of the rivers, at different periods of level of water, such an estimate would not be satisfactory, and there are noc yet any observations of the local rainfall on these ranges and extensive table lands.

The following notes on the route from the Manawatu river to Masterton, through the forty-mile bush, from a journey undertaken by the author in 1868, indicate the nature of this very important track, which might be opened up with a small outlay.

"November 17th, 1868—Left Foxton and rode some twenty miles to Kairanga, on the Manawatu river. Left horses here and crossed river to south bank; walked four miles over a gradually rising country, and camped at foot of first rise of main range, on the Kahuterawa stream: this is a considerable height above the sea, probably 100 to 200 feet.

"18th—Commenced ascent of Tararua range: top of first rise at Tirohanga is about 1200 feet above where we left this morning; goes on level for some way, then a rise of 200 feet more at six and three-quarter miles from the Manawatu, again a rise of 490 feet to summit at Tipakirikiri, which is thus 1800 to 1900 feet above foot of range, at camp this morning. Fine view from here over Tongariro, Manawatu, and Rangitikei country, Ruapehu and some of the Forty-mile bush. Descended to foot of range, 1440 feet. Thence to Mongahao river, descending 280 feet further, or in all 1700 feet from summit to Forty-mile bush country. From the Manawatu by this track to the Mongahao river is twelve miles, passable for horses; cut by Mr. Carkeek, Assistant Surveyor, in 1868. The track stops at Mongahao. Diverged down river a little, and took track to Tutaekara clearing and native pa—about four miles.

"19th—Followed on the old native track (from Ahuriri to Wairarapa) about four miles to Te Hawero clearing—level country. The track from Manawatu might join here, and there is an old track from here to Alfredtown. Four and a half miles further crossed Mangatainoko river: country level for some distance. At, say, eight and a half miles from Te Hawero track rises on a ridge, about 550 feet, and then falls with a good descent 220 feet. Then across a table-land which I estimate some 1100 feet above the sea. Camped about fourteen and a half miles from Te Hawero.

"20th—A mile on crossed Kahepurapura, and also another strong stream, passing over good slopes, rising and falling, say, 100 feet: reached Makakahi river at 8 p.m., nineteen miles from Te Hawero. This is the boundary of Crown land. Two miles on crossed Mangahinau stream, and followed its course for some way. One and a half miles further crossed Mangahuarere stream. At 11.20 a.m. crossed last stream on this side of watershed, say, twenty-four miles from Te Hawero. The bush along this track is very open and free from supple-jacks and scrub: a good horse road very easily made. The track now ascends the water-shed range—rises some 500 feet to a flat top, ascent pretty good. Flat at top, say one and a half miles, and then a descent of 700 or 800 feet to crossing of Ruamahanga river, at the head of Opaki plain, some fourteen or fifteen miles from Masterton. This descent is steep, but by exploring we found a leading spur from the flat top, going about one and a half miles lower down the Ruamahanga, which gives a good descent: we marked and partially cleared this. Crossed the Ruamahanga at 1.30 p.m., and walked over the Opaki plain to Masterton, which we reached about 7.30 p.m."

ART. XLIX.—*On the Raising of the S.S. "Taranaki."* By J. T. STEWART.

(With Illustrations.)

[*Read before the Wellington Philosophical Society, November* 13, 1869.]

ALTHOUGH this subject has been already brought a good deal before the public, and the main facts stated, I have thought it advisable to lay a more detailed account of it before the society, at the risk of appearing to go over a good deal of the same ground that the public prints have already done.

Taking a good deal of interest in this matter from its start, I have collected the following details, principally from information supplied to me by Messrs. Seagar and Thirkell; and I have made the accompanying sketches from that information, and from inspection of the gear used by them.

The screw-steamer "Taranaki," belonging to the New Zealand Steam Navigation Company, was wrecked and sunk in Bowden's Bay, Tory Channel, Queen Charlotte's Sound, on the 19th August, 1868.

Her tonnage is 299 register, h. p. 100, length of keel 182 feet, beam 25 feet, and depth of hold 16 feet.

She was a new boat, built on the river Clyde, in Scotland, a locality now taking the lead in British iron shipbuilding.

Shortly after the wreck the company called for tenders for raising her.

The Directors, however, declined undertaking the task of raising the wreck, and it was sold to a few residents in Wellington, in the beginning of March, 1869, who then took steps for raising her.

Several schemes were proposed to them, but that submitted by Messrs. Seagar and Thirkell, of Wellington, was chosen, and the carrying out of the operations was entrusted to them; and the result shows the choice was judicious.

I shall endeavour to give a short account of the scheme as proposed for raising her, and then give some notes of the successful carrying out of the operations.

The wreck was supposed to be lying in about one hundred feet of water, and the weight to be raised was estimated at about 450 tons.

1st. There was the floating-power required as a base to work from, and to carry this weight in addition to the men and the plant or apparatus.

2nd. There was the apparatus required to lift the vessel from this floating base.

For the first purpose four pontoons were planned with the following dimensions: two of them were 95 feet long on top, 91 feet long at bottom, 14 feet wide at top, 12½ feet wide at bottom, and 8 feet deep. The other two were 85 feet long on top, and 81 feet long at bottom, and of the same breadth and depth as the first two; strongly framed, decked, planked, and caulked, and with three watertight bulkheads in each.

The pontoons were built by contract, at Picton, of N. Z. white pine.

These four pontoons, if sunk to a depth of 6 feet, would represent a displacement of 775 tons nearly, and if totally submerged, of some 1050 tons; thus allowing an ample margin for the weight of the sunken vessel, and also for that of the necessary men, tools, and gear, besides their own weight.

In working, it was found that when the weight came on, they had a displacement of 5 feet in depth, and it was calculated that out of this about 400 tons was due to the weight of the wreck under water, and the remainder to that of the pontoons themselves, with the workmen and gear.

The iron work for the lifting apparatus was designed and made by Mr. Seagar, at his works in Wellington.

The lifting apparatus may be described, generally, as consisting of forty-four long iron rods, with hooks at bottom to catch in the circular openings, or ports, in the sides of the vessel—twenty-two upon each side. (See plate XII.) The upper ends of these rods led up to the pontoons, and were attached to screws on the top of each rod for raising the weight.

More particularly,—each of these rods was of 1¼ inch diameter round iron. This was equal to take a strain of sixteen tons each, or in all 700 tons. The rods were divided into links twelve feet long, with oval eyes, connected by short double links, 9 inches long, of 3½ in. by ⅝ in. iron, with 1¼ in. pins. In working it was observed that it would have been an improvement to have had the rods in shorter links, say of four feet each.

The hook at bottom was made of 3¾ in. by 1 in. iron, and thickened where it took hold of the port-hole to 2½ inches, and an ingenious slide or stop took hold of the lower side of the port-hole, and supported the hook after it was fixed, thus preventing it slipping out when the upward strain was relaxed, and this was found effectually to keep the hook in position. This stop was of 2½ in. by ½ in. iron, with a slot in it, to enable it to move along two pinching screws through the side of the hook. (See sketch.) This stop was fastened by the diver as soon as he got the hook in its place. When working, a short length of chain, 3 feet to 4 feet long, was attached between the hook and the lower end of the suspending rod.

The upper end of each suspending rod had two shorter links of 4 feet each, and above these, and forming the upper length of suspension bars, was the fleeting link, which was double and of flat iron, each piece being 3 feet 5 in. long by 4 in. by ⅝ in., and pierced with 1½ in. holes, four and a half inches apart, so as to admit of adjustment of the length of the bars, when fleeting the screws to take a fresh lift. These fleeting links were attached at the top to the bottom of the lifting screw.

The lifting screws were of 2⅜ inches diameter iron, and screwed for 2 feet 3½ inches in length, and had four threads to an inch. Each screw was turned by a spanner, or lever, 5 feet long, of 1½ inch round iron, moved by two, or sometimes three, men, and with an eye fitting over the nut. The nut worked upon double washers or plates, bearing on a wooden block which rested on the cross logs of the pontoons, as will presently be described. These washers were adapted to the special nature of the work to be done.

The lifting of a movable body at such a depth, acted on by currents, and

the pontoons themselves affected by currents and winds, must involve a certain amount of swinging motion, horizontally or laterally ; besides the tops of the rods were not all vertically over the hooks in the port-holes.

To allow for this the upper washer of wrought-iron was rounded in the bottom, and rested and fitted in a hollow recess in the cast-iron washer or plate, which hollow was turned so as to fit accurately to the bottom of the upper washer. This then allowed to the upper washer, the screw, the nut, and top of rod, a certain amount of oscillation, to suit which the aperture in the cast-iron washer, or plate, was beveled out somewhat towards the lower edge. (See sketch).

A set of counter-balance weights had also to be provided to carry the weight of the rods, when adjusting or fleeting the screws. These weights were carried by ropes attached to the upper part of the rods, and passing over sheaves placed in the cross logs which rested on the pontoons. The weight was made sufficient to balance the weight of rod, and this arrangement allowed the pontoons to rise and fall with the tide.

The four pontoons were placed two on each side of the sunken vessel, so that a space was left between them over the wreck, about one foot more than the breadth of the "Taranaki."

Twenty-two sets of cross beams, each carrying two lifting rods, rested on the pontoons, and passed across over the wreck. These beams were double, consisting each of two pieces, each piece 18 in. by 9 in., placed five inches apart, and bolted together in three places by three-quarter inch bolts.

The length of the beams was from 48 feet to 53 feet, according to position. They were of Kahikatea, or N. Z. white pine. They proved strong enough for the strain, but with nothing to spare, deflecting a foot in the middle when the strain came on them. Two of them sprung in the early part of the work, but they were of lighter scantling, and were strengthened and used afterwards.

On each of these beams, and over the inner side of the pontoons so as to plumb the sunken vessel's sides, were placed two blocks of hard wood (Rata), each 15 in. by 5 in., and 2 feet long, with a hole 5 inches square for the lifting rod to pass through, and on this block was placed the plate, or washer, already described, carrying the upper washer and nut of the lifting screw. (See sketch.)

On an average, fifty-four men were employed.

The mode of screwing up a lift was, first to screw up all the screws on one side for one foot, or half the length of lift, then proceed to the other side and screw up two feet, or the full length of the lift, and then go back to the first side, and screw up the remaining half of the lift for this side.

The mode of fleeting the screws was, to begin to fleet simultaneously the foremost screw on each of the two pontoons upon one side, and the aftermost screw on each of the two pontoons on the other side; and then, when these had been adjusted and were being tightened up, the screws next but one to the four already fleeted were slacked off, and so on, till all the screws were gone through and got ready for a fresh lift. Thus no one log had the strain taken off both of its ends at one time. In this operation eight sets of lifting rods were relieved of the weight at one time, and the weight of the wreck was then borne safely by the remaining thirty-six rods.

They could fleet and screw up twice in one day, taking about an hour to fleet, and three hours to heave up a lift.

Two divers were employed, who had the arduous task of fixing the hooks under such a depth of water, opening the ports, cutting away the woodwork, and other jobs, such as sending up the anchors and chains, etc.

Their labour was much facilitated by the use of a box, or cage, 6 feet by

3 feet, formed of iron bars placed openly, and having a wooden floor. This was slung from the pontoons, and let down where the divers were to work, and in it they stood when at work. After hooking on the lifting hook to the port, the diver fixed the stop, or slide, to prevent the hook falling out, and also made fast the rod to the ship's rail above, to steady it.

It was at first intended to make use of the lifting power of the tide, and assist it by filling the pontoons with water, and pumping them out as the tide rose. For this purpose valves were put in the bottom of the pontoons, and pumps provided.

This plan was put in operation for some time, until, as the vessel was hauled ahead, it was found that the bank was so steep that she was liable to slip back when allowed to rest on the bottom. At one place the stern was observed to have thirty feet more water over it than the bows had, so sudden was the incline, and for a short distance near the top of the bank, the inclination was nearly 1 to 1.

It was found necessary after this to keep her always suspended or carried from the pontoons, and to trust to the lifting power afforded by working the screws.

This steep bank added much to the difficulties to be overcome, and the vessel was brought gradually side on to it, so as to bring her more to a level. This was done by lifting at each lift the stern more than the bows, and hauling it round at same time up the slope of the bank.

As the vessel was lifted she was hauled ahead by being made fast by a chain cable from her bow to the "Ladybird," which steamer was hauled ahead from time to time, as required, to moorings placed in shore.

The position of the wreck may be briefly described.

She lay on a comparatively level bottom of soft clay and shells, with a rise of six feet in the length of the vessel towards the bows, and the stern was sunk about seven feet in the mud; a great weight of mud was piled upon the poop deck, probably thrown over the stern when she went down. At the stern the depth of water was 17½ fathoms, or 105 feet, at high-water.

This nearly level bottom extended ahead for about sixty feet, when the foot of a bank was reached. This bank rose at a rate of thirty feet in two hundred feet, or in about the length of the vessel, for a distance ahead of some five hundred feet, when the inclination increased to a rise of twenty-seven feet in thirty feet, for a short distance up to the top of the bank, over which there was a depth of twenty-one feet at high-water.

On getting over this bank the depth increased to twenty-four feet for some distance, and then gradually shoaled in shore for a length of six hundred feet, or thereabouts, farther.

The rise of tide at springs was 4 feet 6 inches, and at neaps 1 foot 6 inches, and there was a current on the ebb which greatly interfered with the operations of the divers for two-thirds of the ebb. The position, however, was landlocked and sheltered from any waves or swell of consequence.

A notice of some of the damages sustained by the vessel may be interesting.

First, the damage sustained when she struck on the rock before sinking, as found after she was raised:—

The extent of the damage lay within three frames, or a length of 4 feet, in the engine room compartment, on the port side, close behind the donkey engine. There was a crack or rent in one of the plates; the top of the crack was about 4 feet under the load water-line; the crack was alongside one of the angle iron ship's frames. It was 3 feet long, and of an average width open of 1 inch. The frame was bulged in about 8 inches.

There was also a hole about 2 feet aft of the crack and on the same level;

this hole was about 3 inches diameter, and had a sharp pointed bit of hard rock sticking in it.

The "Taranaki" was divided into three compartments, by watertight bulkheads. The damage took place in the centre one, but the aft compartment seems gradually to have filled. The fore compartment evidently remained unfilled, as will be noticed afterwards.

The vessel kept afloat for seven hours after she struck, and then went down stern first, burying the stern in the mud, scooping up twenty or thirty tons of soil on to the poop, knocking away the poop rail and stanchions round the stern, leaving the steering gear uninjured, but twisting round and breaking the rudder. The screw propeller had been knocked off on the rock shortly after she struck.

The boiler was injured when she sunk, and was found to be very seriously damaged, having collapsed from the outside pressure of the water as the vessel suddenly sunk to the depth of 17½ fathoms, assisted probably by a partial vacuum formed by condensation of the steam. (See sketch of boiler.)

The top of the shell, although arched and strengthened by angle iron ribs round the top, with 1¾ inch stays from the angle irons to the bottom of the boiler, was forced in 18 inches, crushing and bending these stays, and also the gusset stays 1 foot wide by 1 inch, at the angle formed by the top and back of boiler. The 1¾ inch stays, from top of boiler to top of combustion chamber, also were broken and bent. In collapsing, the top of the boiler had dragged back the uptake for 18 inches on top, taking the steam chest with it, and also dragged the back of the boiler in towards the combustion chamber, leaving the stays sticking through the back.

The combustion chamber, the tubes, tube plates, and the bottom and front of the boiler were found uninjured and not moved.

In the fore deck, over the forward compartment, which seems to have remained free of water till after she sank, ten deck beams were bent down 8 inches by the pressure of the water from outside, bending the 3 inch iron stanchions supporting them from the lower deck, and the hatches were found forced inwards.

The forward watertight bulkhead was bulged in forward about 1 foot.

Second, the effects accruing from her long retention under water:—

She sunk on the 19th of August, 1868, and was pumped out, on raising her, on the 26th of September, 1869,—a period of over thirteen months.

Her hull was completely coated with shelly encrustation, except the bottom, which the marine paint had kept tolerably clean. Her small spars and upper decks were completely worm eaten and gone; any Teak wood was found sound; the cabin fittings, where painted, were in general sound.

The engines were found in working order, all the journals and bearings bright and clean. The wrought-iron starting gear tarnished but not damaged, and the cast-iron work uninjured.

One of the cylinders was free of water, the other was full.

Having thus attempted to give a description of the plan of operations, the position of the wreck, and mentioned the principal damages she sustained, I shall give some notes of the operation of raising the "Taranaki," interspersed with a few extracts from a journal kept by Mr. Thirkell; and thus give some idea of the nature of the work.

On the morning of June 23, 1869, a start was made by the adventurers from Wellington, in the steamer "Ladybird," hired as a tender during the operations, and they got to Picton the same afternoon, and next day launched two of the pontoons and took in the cross logs and moorings.

On the 26th June, left Picton, and towed the two pontoons to Bowden's bay, where the "Taranaki" lay sunk. From this time to the 10th July they

...nd chains out of the "Taranaki" by aid of the divers, and mooring the two pontoons and the "Ladybird,"—a work of considerable difficulty; also getting the cross bearing logs bolted together in pairs, and other preliminary arrangements made.

On the 12th July, got the stage for the divers into position; one of the divers went down and opened one of the port-holes, found depth to port-holes, at low-water, to be 88 feet.

From this date up to the 21st, engaged getting lifting rods from these two pontoons hooked on to the ports by the divers, which required much patience, perseverance, and repeated attempts before completion.

The divers seem to have remained down from twenty minutes to forty minutes, often over an hour, and on some occasions for one hundred and five minutes.

On the 21st July, the "Ladybird" went to Picton, and returned on the 23rd with the third and fourth pontoons, and they now moored the "Ladybird" in position for hauling the "Taranaki" ahead, having 60 fathoms of chain ahead, and with the "Taranaki" made fast to her stern with 30 fathoms of chain; also moored the third and fourth pontoons in position, and this with getting the rest of the cross logs ready, and other work, occupied until the 26th, on which day the diver examined, and reported on, the extent of the injury the vessel had received when she struck, and which has already been described. From this time up to the 6th August, getting the lifting rods from the third and the fourth pontoons down and fixed, and getting the other gear ready. For the scupper holes, one or two of which were used, a special hook had to be extemporised, as the hooks made for the port-holes would not do for them.

Extracts from Log:—"Wednesday, 14th July, 7.15 a.m., commenced work, light S.W. wind; men rigging up gear for supporting bars, and attending to diver.

"One of the divers went down at 7.45 a.m. to hook on, down thirty minutes, went down again at 8.35 a.m., down sixty-three minutes, wanted stage shifted; went down at 10.16 a.m., down twenty-nine minutes, came up, reported slide too short for the port; went down at 11 a.m. to unhook and send up the slide to alter, down sixteen minutes, came up; the other diver went down at 12.55 p.m., took slide with him.

"Put hook in and secured it with slide, down twenty-five minutes, came up to shift stage; went down to second hook at 1.40 p.m., after trying to cut covering board, came up to shift stage a little aft, down twenty minutes; went down again at 2.5 p.m., down fifteen minutes, came up, could not work, tide too strong; put down bars ready for divers next day, and got blocks and balance weights ready.

"Tuesday, July 20—Strong N.W. wind and dry weather; 8 a.m., commenced. Men putting four full lengths of bars, with hooks, etc., down, ready for the diver to hook on when the tide slacked a little; shifting stage, which was foul, and took a long time to clear, on account of the tide drifting it against the vessel's side; fitting up the remainder of the sheaves on the port side, and two on the starboard side, and altered the rope from the blocks to the sheaves, and found the balance weights worked much better.

"One of the divers went down and commenced to cut out and unscrew port-hole No. 13, at 11.45 a.m., hooked on and came up after being down forty minutes; got refreshed a little, and went down at 12.40 p.m. to clear away for hook No. 12; hooked on, and screwed up and lashed up Nos. 12 and 13 to the rail, and then came up: down sixty minutes.

"Part of the men went to dinner, and part remained to shift stage and ladder

ready for the other diver, who got dressed and went down at 2.40 p.m. to hook on Nos. 14 and 15; succeeded in opening three port-holes, and cut away and screwed up Nos. 14 and 15, put lashing on the rail, and came up after being down eighty-five minutes. The 'Storm Bird' arrived from Wellington with some bars, etc., as the after lengths had been found 4 feet to 8 feet too short.

"Saturday, July 31—Strong N. wind and rain all day, one diver went down at 9.25 a.m., as soon as the hooks were altered for the scupper hole, down thirty-eight minutes; came up and reported the hook too large for the hole; made it smaller at the point, and then diver went down at 11.12 to put it in, down forty-three minutes, came up and reported the hook half way in, and could not get it any further.

"The other diver got ready and went down at 12.45 p.m., he drove it up and wedged it with three iron wedges, down sixty-five minutes and came up to refresh: went down at 2.10 to find the middle scupper hole, found it and put hook in half way and could not get it further in, nor out again; down fifty minutes, came up and could not go down any more to-day."

By the 7th August, all was ready to try a lift, and on that day we find the journal saying:—"Weather fine all day, commenced at 12.30 p.m., sunk pontoons by letting in water; connected on at 1.30 p.m., and screwed all the bars tight, and began to pump out at 2.45 p.m., assisted by the whalers from the Sound. Vessel began to lift at 3.30 p.m.; all the water pumped out at 4 p.m. The pontoons rose considerably, two of the after logs of the fore pontoons sprung, being undersized; hove in by the 'Ladybird's' windlass as the tide flowed, got ahead 50 feet, and ceased at 8 p.m."

This was the first lift, and rather an exciting time. The lift got was about 5 feet, of this 3 feet was due to the rise of the tide, and 2 feet to the effect of pumping out the pontoons.

When she first started out of her bed in the mud, the pontoons started or jumped up nearly six inches; before this start the deck of the pontoons was 14 inches out of water on the inner side, and 2 feet on the outer. (Usually, however, it was afterwards found there was none of this jerking up, but a steady lift.) The following days the same mode of procedure went on.

"12th August—4 a.m., commenced to connect bars to screws, and screwed down about 10 inches; at 6.45 began to pump the water out of pontoons, and with the tide lifted the bow up about 5 feet, but found the bank with a greater rise than was expected, which makes the after end difficult to ground, hove ahead with some of the men, and the remainder finished pumping; at 12.30 p.m. found the anchor, in heaving ahead, 'come home;' could not heave any more until it is lifted, and placed farther in shore, with one of the pontoon's mooring anchors to back it."

They had now got the wreck hauled ahead close to the rise of the steep bank, and went on lifting and hauling until the bows got well up, while the stern got to the foot of the slope, not very much higher than it was originally.

On the 17th August, they sounded and found the vessel to be 26½ feet higher at the bows than at the stern, being about the angle of the bank at this place. On Saturday the 21st August, they found as the steamer settled down aft, that she slid down the bank for 16 feet; so they concluded that she would have to be lifted over the bank by the screws only.

They now began to put more men on the screws in the after pontoons, so as to lift the stern a little more than the bows, at each lift, so as gradually to get a more even keel on the wreck, and as they did so, hauled the stern sideways on to the bank, as well as hauling her ahead; the log going on thus on the 25th and 26th:—"Divers commenced to take off some of the long lengths of the bars.

"30th August—6 a.m., commenced work; fine clear weather.

"Began to screw up; went to breakfast 8 a.m., began work 8.45, finished up the length of the screws, and fleeted down again, and recommenced to screw up; went to dinner at noon; commenced at 1 p.m., screwed up the full length, and began to fleet part of the screws; ceased work at 5 p.m., having lifted the fore end 3 feet, and the after end 4 feet.

"31st August—Day fine throughout, with light N.W. wind.

"At 6 a.m. commenced to take off the second length of long bars of the two after pontoons, and fleet down the screws on the fore pontoons.

"At 10 a.m. commenced to heave up the length of the screws; hove in by the north-west chains, and hove the 'Ladybird' ahead; 2 p.m., fleeted down the screws and commenced to heave up the second lift, got about two-thirds of the screwing up, and ceased work 6 p.m., having lifted about 3½ feet during the day, and gone well up the north-west bank, as well as ahead.

"September 2nd—Fore lower-mast head about 2 feet out of water.

"September 3rd—Found two of the hooks had torn away the plate of the port-holes, not having hold of the angle iron. Let water into pontoons to ease the bars, the vessel resting on bottom, and sent down both divers to put in the two hooks properly. Shifted the whole of the logs forward upon the after pontoon, and took the foremost log into the middle to the two ports left vacant.

"Having pumped water out of pontoons, after dinner commenced to heave up, and got a lift of 2 feet. Ceased at 5.30 p.m.

"September 4th—Fore-top out of water.

"September 6th—Fore-top 2 feet, and main-mast head 1 foot out of water.

"September 11th—Lifted to-day 3 feet 9 inches at fore-mast, and 4 feet 3 inches at mainmast; forecastle deck 10 feet under water, quarter-deck 25 feet under water.

"September 13th—Screwed up 3 feet at fore-mast, and 4 feet aft; found the seams of the pontoons opening a good deal from exposure to the sun.

"September 14th—Lifted 3 feet 4 inches forward, and 4 feet aft.

"September 15th—The divers began to take off last lengths of long bars: lifted at fore-mast 2 feet 5 inches; the fore end of the forecastle deck out of water, found the pine deck very much worm-eaten.

"September 16th—Lifted forward 1 foot 5 inches, and aft 2 feet.

"September 17th—Let water into pontoons to slack the bars; shifted all the logs to a more direct lift, and took one log and screws from the after pontoons, and put them on the fore pontoons, fleeted the screws down, after placing the logs in position; pumped water out of pontoons, and lifted with the screws; lifted to-day at fore-mast 2 feet, and aft 2 feet 2 inches, and hove the vessel ahead about 20 feet.

"September 18th—Lifted at fore-mast 2 feet 6 inches, and aft 4 feet.

"September 20th—Raised the logs which were over the forecastle and the deck-house; came ahead to-day about 70 feet; lifted at fore-mast 1 foot 3 inches, and aft 3 feet.

"September 21st—Hove ahead at high-water; let water into pontoons; cut two logs for blocks for packing up; screwed about 6 inches, and pumped out water from pontoons; lifted about 2 feet 6 inches; floated over the bank and ran ahead with the strong wind towards the beach for about 300 feet.

"September 22nd—Hove ahead at high-water, and let water into pontoons to block up logs, which are now upon the rail of the "Taranaki." The two divers down to examine the cracks in plates, and stop up holes, pumped out the pontoons.

"September 23rd—Commenced to pump out the fore hold of the wreck.

"September 24th—Continued pumping.

"September 25th—Pumping out wreck and stopping leaks and port-holes. (This was done by putting a sheep-skin and a board over the hole, and screwing it tight up to a cross bar placed inside.)

"September 26th—Pumping out and repairing cracked plate. (This was temporarily done by the diver with wooden wedges, and afterwards, when the water was got under inside, by the engineers putting a plate and a sheep-skin over it.)

"September 27th—Removed the lifting rods, screws, etc., and put them on board the 'Ladybird,' repaired cracked plate, and fitting up donkey engine.

"September 28th—Got the donkey engine to work, cleaning out vessel, etc.

"September 29th—Moved the 'Taranaki' alongside of the 'Ladybird.'

"September 30th—Taking coals out of the 'Taranaki' into the 'Ladybird,' and mooring pontoons. Covering the worm-eaten decks with planks to walk upon.

"October 1st—The steamer 'Wanganui' arrived from Wellington with tow-ropes. Left Tory Channel in tow of the 'Ladybird' and the 'Wanganui,' at 10 a.m., and reached Wellington safely in the afternoon at 4.30, after a fine passage across Cook's Straits. The vessel very tight, and not making any water."

The total lift was 92 feet; the weight of wreck about 400 tons.

ART. L.—*On* THOROUGH DRAINAGE. By J. C. CRAWFORD, F.G.S.

[*Read before the Wellington Philosophical Society, September* 18, 1869.]

As the subject of thorough drainage is evidently but little understood in this part of the world, and as I have had some experience in the matter in Scotland, I propose to make a few remarks, and to lay down a few elementary rules on the subject, which I hope may prove of use.

It is often supposed that in drainage it is sufficient to remove water from the actual surface, whereas the beneficial results to be obtained are gained by lowering the water *table*, or that level at which the underground water rests, to a sufficient depth to allow the roots of plants to get well down, and also to allow rain water to percolate freely through the soil, instead of lying stagnant on it, carrying with it ammonia and portions of atmospheric air, which assist in the decomposition of matter previously inert.

It has been found practically, that a depth for drains of about four feet is that which is economically the best. It becomes very expensive to sink below this depth. If the subsoil is rocky, and presents great obstacles to sinking, a depth of three feet six inches may be considered sufficient.

The main drains ought always to have an additional six inches in depth below that of the small drains.

If a field has an irregular surface half mains are frequently used, so as with more convenience to run the water into the main drain, than if all the small drains were led into it direct.

The distance between each drain generally varies from twelve to thirty-six feet, according to the stiffness of the soil. In heavy clay the short interval of twelve feet is required, in gravelly soil thirty-six feet would be sufficient. The drains should follow the steepest slope.

The main drain is generally taken parallel to the fence along the lowest

side of the field, at a distance of the breadth of a furrow from the fence, and empties by one outlet at the lowest part.

It is of great importance to have as few outlets as possible.

If stones are actually on the ground, it may be found cheaper to use them for filling the drains, but upon the whole, tiles are found the most economical. They are lighter than stones, and therefore require less carriage. The water also runs more freely in them. One to two-inch pipes are generally used, and it is always best to lay them with collars. It is unnecessary and wasteful to have the same sized tile at the upper part as at the lower part, of a drain. Mains vary in diameter, according to the amount of water. From four to six-inch pipes are generally sufficient.

The average expense, in Great Britain, of draining an acre, may be stated at about £5 10s. In this country it would cost considerably more. Until the expense is reduced, the system is therefore not likely to come into very general use, but for small pieces of ground, and particularly gardens, it ought even now to be applied. In garden ground, no doubt, the pipes are apt to get choked with roots, but the damage soon shows itself, and the pipe must simply be lifted and cleaned, and then relaid.

Although there is much excellent natural drainage in this country, yet many districts would be immediately improved by thorough drainage.

Without going far, I might mention Karori, Porirua, and parts of the Hutt.

RECAPITULATION.

1. Drains should follow the steepest slope.
2. They should, if possible, have a minimum depth of four feet *perpendicular*.
3. The main should have a depth of six inches more than the small drains.
4. The chief main should be cut along the lowest side of the field, parallel to the fence, and should empty by one outlet only.
5. The interval between the drains should vary from twelve to thirty-six feet, according to the stiffness, or openness of the soil and subsoil.
6. It is a waste of material to put the same size of pipe at the upper as at the lower part of a drain.
7. Pipe tiles are far more permanent, and in the long run cheaper, for drainage, than any other material. They ought to have collars. The run of water is more free in them than in any other kind of drain.

A little consideration will show what a difference it will make in the fertility of land, if the water, which now lies, during the winter months, either on the surface, or close below it, and in a stagnant state, is kept flowing at a depth of four feet below. In the one case the roots of plants are perished by the water, in the other they are nourished, and the rain water also, percolating freely, assists decomposition, and removes noxious matters.

Wet land in its natural state is unfit to receive manure, which is wasted if put upon it. When drained it is ready to take advantage of any application of fertilizing material.

In its natural state the ground is hard to work. It is sodden with water in winter, and forms hard clods in dry weather. When drained, it is easily worked at all seasons, and breaks up into fine mould.

The returns from drained land are proportionately great. I can speak from experience when I say that nothing pays better in Great Britain than judicious drainage of land. On the other hand, a large landed proprietor in the Midland Counties informed me that he had thrown away £24,000 upon drainage which would have to be entirely done over again. He had been persuaded that a two-foot drain would be ample, and found that the depth

was quite insufficient. It was at first supposed that the water ought to find its way directly from the surface to the drain, hence the idea of a two-foot drain, but this view was found to be erroneous, and the true principle decided to be as follows:—land is saturated with water rising to a certain height; when the water reaches that height, it will run off if opportunity offers. If no outlet appears, it will rise above the surface, and form a lake or a swamp. If the water table be lowered by the construction of drains, an outlet is offered at a lower level for *the subsoil water, or water of capillary attraction, which forms the chief supply of water in the drains.* This water being kept flowing, makes room for rain water to get down to the subsoil, instead of lying stagnant on the surface or on the upper soil. No doubt, at times, rain water may pass direct into a drain, but it is not in the usual course. It is found, therefore, that by keeping the subsoil water running at a depth of, say, four feet, that the heaviest rain cannot leave water resting for any time on the surface, but that it must find its way down to the subsoil, thus percolating through, and improving the soil, instead of running violently over the surface, and washing away the finer parts of the ground.

ART. LI.—*On the Surface Fall of Water, as a guide for Under Drainage.* By JAMES BABER, C.E.

[*Read before the Auckland Institute, July* 5, 1869.]

THE practical part of drainage is an agricultural subject, but the principles from which rules for practice are deduced, belong to general science. In this colony it is of importance that drainage of land be conducted on proper principles. To examine the properties of one of these is the object of this paper.

Water on the surface, descending from a higher to a lower level, follows the general law of bodies in motion, moving in the line of least resistance. At any point in the descent, this line will be found to be at right angles to the level or contour-line of the surface at that point. Water drains off an even surface in straight lines perpendicular to the contours, or in curves having chords in the same direction. So if the courses of water over any land be carefully marked, and lines be drawn at right angles to these courses, the line so drawn will form parts of the contours of the surface.*

A drain laid in the line of these courses will possess the following properties:—

Water will enter it on both sides with an equal pressure, the depths from the surface being equal. It will drain equally an equal distance from each side, for if any two equidistant points be supposed at the depth of the drain, on what may be termed the drainage surface, on opposite sides, and opposite to the line of drain, these points and the drain will be on the same level.

The drain will not leak, water will not enter on one side and escape through the joints on the other side, for having sunk through the soil to the level of the drain, it must descend through the pipe, that being in the line of least resistance.

The forces which chiefly act on water descending from the surface of land to the drainage level are:—impulse from water in motion, and gravitation. The capillary and molecular attractions, and the absorbent powers of the soil, vary so much, that they need not be calculated for general rules. These two principal forces will operate in the line of descent, at right angles to the contour.

The deduction from this principle is, that the nearer a line of drainage approaches the perpendicular to the contour, the more efficient that drainage will be.

* A diagram to illustrate this has been omitted.—ED.

Art. LII.—*On* Sewage Irrigation, *and its results, with a Sketch of the Main Drainage Systems of London and Paris.* By T. S. Tancred, Assoc. Inst. C.E.

[*Read before the Philosophical Institute of Canterbury, August* 4, 1869.]

There are few subjects more interesting to the inhabitants of towns generally, than questions relating to sanitary arrangements, and properly organized systems of main drainage.

Although it might be thought that in every large town, such a system had been in partial operation since the times of the Cloaca Maxima, yet it is a curious fact that, until very recently, no large city, either in England or on the Continent, had paid any real attention to this important subject.

The author therefore proposes to state, briefly, what steps have been taken in London and Paris to secure effectual drainage, and to compare the working of two distinct systems varying in some important particulars.

Up to the year 1815 it was illegal to discharge any sewerage into the drains of the city of London. After that date it became impossible to prevent the influx of sewage matter, and in 1847 the law was reversed, and drainage into sewers rendered compulsory.

Commissioners were appointed to carry out the various works necessitated by such a change, and held office until the year 1856, when the present Board of Works was constituted.

The Board, after full investigation, resolved to adopt the scheme elaborated by their own engineer, Mr. Bazalgette, under whose most able administration the works were commenced in the year 1859, and will probably be completed in the course of a year or so, contemporaneously with the Thames embankment.

In Paris the cholera attack of 1832 first opened the eyes of the inhabitants to the sanitary condition of the city, and such vigorous measures were adopted, that in four years their sewerage system was doubled, and within the next twenty-two years quadrupled. Paris is built in blocks, each block having its own cesspool, which is emptied at stated times, the contents deodorized and part sold. All waste water from the houses, and rainfall, passes into the sewers, which are of sufficient diameter to allow of men working freely in their interior, and of their serving as subways for the conveyance of gas and water-pipes, and lines of telegraph. They are cleaned by means of trucks running on iron rails, and in the case of the main sewers, by a species of boat propelled by the pressure of the water. The annual cost of cleansing amounts to about £30,000, whilst it is understood that little or nothing is realized by the sale of deodorized soil.

Many difficulties arose in dealing with the sewage of London, as is generally the case in every town which has been built before any definite idea has been formed as to the ultimate disposal of its sewage; one of the main difficulties being, that the discharge was affected by the tide, a considerable area being below the level of high-water.

The six questions which presented themselves were:—

1. At what point, and at what state of the tide, could sewage be discharged into the river, so that it should not return within the more densely inhabited portions of the metropolis?

2. The minimum fall of the intercepting sewers?

3. The quantity of sewage to be intercepted, whether it passed off uniformly day and night, or in what manner?

4. Was rainfall to be included, and what was its probable amount?

5. Having regard to all these points, how were the sizes of the sewers to be determined?

6. What description of pumps were best suited for lifting sewage?

After due consideration and many interesting experiments, the conclusion was arrived at, that a district of average density of population contained 30,000 people per square mile, and the sewage was proved to be nearly equal in amount to the water supply. The calculation was, that the average daily amount to be provided for would be five cubic feet per head per day. The total areas drained on the north side of the Thames amounted to about forty square miles, on the south side to about the same, with a quantity of sewage amounting to 40,000,000 cubic feet per day on the north, and 23,000,000 cubic feet per day on the south side, respectively.

In 1865 a Private Bill was brought before a select committee of ten members of the House of Commons, having as its object the utilization of the sewage on the north side of the Thames. The Board of Works had previously advertised for tenders and proposals for effecting that purpose, with a view of making the sewage repay the cost of maintaining the drains,—the cost of construction, which will amount to about £4,100,000, being provided for by a rate upon an estimated rateable value of £14,500,000. The scheme which the author is now describing was the one approved by them, and to the advocates of which they made a grant of the total sewage on the northern side, for a period of fifty years, upon certain terms. After a protracted struggle the Bill was passed, in spite of the determined opposition of the Council of the City of London, who insisted that the terms were not sufficiently favourable to the ratepayers, the maximum estimated price per ton, twopence, being, in the opinion of their advisers, far beneath the true value of the sewage.

The main works, which were estimated to cost about £3,000,000, were then commenced, and for the purpose of testing the value to the farmer, of London sewage, taken just as it came down the outfall sewer, the directors determined upon renting a small farm of about two hundred acres, in the vicinity of Barking, to which the sewage was forced by steam-power, at the rate of 175 cubic feet, or five tons, per minute. A tank, holding thirty tons, was erected, into which the sewage was delivered from the main, so that at any period in the day the quantity delivered could be accurately gauged by the manager. His record, compared with the indicator attached to the engine, gave correct and reliable data upon which the reports submitted to the public were founded.

Up to this time so little was known of the capabilities of sewage as a manure, and the quantities in, and intervals at which it should be supplied, that the directors considered they could not do better than conduct their experiments on a thoroughly practical system, and one which would bear the inspection of both farmers and business men in general; more particularly as there exists in England a strong feeling on the subject of the fouling of streams and rivers, as is shown by the recent action of the Legislature, which is doing its utmost to prevent public bodies and private individuals from turning natural watercourses into noisome and unhealthy cesspools. Oxford and Reading are at the present time liable to penalties of £50 per day, under recent Acts for the purification of the Thames, and the Royal Commission on Rivers, now sitting, will doubtless place many towns under the necessity of instantly carrying out their drainage works, with a view to the utilization and deodorization of their sewage. It thus becomes a serious question whether it will be possible so to utilize these products as to render the residuum harmless, and at the same time to make the necessary works pay a fair interest on the cost of construction.

Sewage irrigation has been carried on at Edinburgh, Croydon, Carlisle, Rugby, Watford, Worthing, the Crystal Palace, and in other places.

The experiments made at Rugby were conducted by Mr. Lawes, a manufacturer of artificial manures, and a well-known agriculturalist, who was also at the time, a member of a royal commission appointed to make experiments and report their results. They were therefore carefully conducted, and the following were the values assigned :—

£15 per acre being the value of the milk derived from one acre of ordinary meadow grass, £25, £33, and £36, were the values derived from the same grass when watered with 3000, 6000, and 9000 tons of sewage per acre. From the use therefore of 1000 tons of sewage, we get a result varying from £3 6s. 8d. to £2 6s. 8d. over and above the amount that would have been produced by the natural grass, assuming milk to be worth 1d. per pint. This gives the sewage an average value of from ·8d. to ·55d. per ton. The sewage which had been used was found by analysis to contain from 15 to 25 per cent. of its manurial properties, owing to the nature of the soil and the slope of the ground, and it might have been advantageously used a second time.

In Edinburgh the results have been more satisfactory with regard to the money value per acre. There the meadows are annually let or sold, the purchasers generally cutting the grass for themselves, at prices varying from £25 to £40 per acre; and at Leith, where the sewage is used a second time, at £30 per acre.

These results are, however, obtained by the use of very large quantities of sewage, as much as 20,000 tons per acre being applied, although its actual manurial value is not equivalent to more than half that of ordinary sewage, as the Foul Burn, by which it is brought down, drains a large area of open country.

At Croydon, after paying rent at the rate of £4 per acre, the gross value of the sewage is returned at from ¾d. to 1d., for Italian rye-grass, per ton, used.

The results obtained by Lord Essex at Watford, by Sir J. Paxton at the Crystal Palace, and by Mr. Mechi, and others, do not admit of accurate comparison, an exaggerated value having been put upon sewage as a manure, and consequently the outlay upon pipes, pumps, and apparatus, has usually been upon far too large a scale.

In the case of the farm now about to be described, it should be borne in mind that the object for which the farm was worked, was not so much to pay a dividend, as to prove definitely the actual value per ton of sewage delivered on a farm, and for what sum per acre a certain quantity of sewage could be economically made available.

So far, the three principal methods of irrigation have been the catch-water, the ridge and furrow, and the hose and jet. These names almost explain themselves; but that there may be no mistake, I may explain, that the *catch-water* is a system of contour ditches communicating with main feeders, each ditch acting as a drain to the plot of land lying above, and a feeder to that below.

The *ridge and furrow* is commonly used when the natural fall of the land is too slight for the catch-water system, and can frequently be made use of in conjunction with, and prior to it. It consists of a series of artificial undulations about 60 yards wide, having a fall of 1 in 140, or thereabouts.

The *hose and jet* is a system of underground pipes, under pressure, having valves at intervals, and junctions to which the hose is affixed, the hose itself travelling on a light carriage to prevent injury to the crop. There is also another system occasionally made use of, viz., wooden or iron troughs, but it is usually auxiliary to the other methods of distribution. In the present example the ridge and furrow, and the catch-water, were the systems employed. The area brought under their operation amounted to about seventy acres, and

the crops experimented upon were wheat, oats, mangold wurtzel, sugar beet, cabbage, onions, lucerne, kohl-rabi, potatoes, flax, leeks, celery, asparagus, strawberries, etc., but principally Italian rye-grass, a patch of *Bromus Schrœderi*, or prairie grass, and ordinary old pasture. Upon its arrival at the farm the sewage was allowed to flow from the measuring tank into another considerably larger, whose top was truly level, thus allowing the liquid of the sewage to flow over its lips, and retaining a greater part of the sediment. This was done to facilitate the labour of cleaning the carriers, but the porous nature of the ground, and the large quantity of sewage absorbed by the carriers, rendered it advisable to allow the sewage to flow, at first, direct into the carriers, which were gradually puddled by the deposit. The farm was pipe-drained, which was also an unnecessary expense with land of so light a character, and with a deep gravel subsoil. So far as experiments have gone, subsoil drainage has been found of little value in sewage irrigation, as in the extreme case of Croydon, where the soil is a stiff clay, the subsoil drains were taken up by the proprietor, who said the grass was better where they had not been laid down. This fact is opposed to the general opinion of the agricultural world, but there is little doubt that a gravel subsoil will carry away a very great additional increase to the rainfall of a tolerably dry country.

The fifty-five and a half acres of Italian rye-grass supported from 200 to 300 milch cows, which were fed upon 2500 tons of grass, 1 cwt. to 1½ cwt. each per day, the produce of 250,000 tons of sewage.

This is taking the whole, and striking an average, but taking that acreage, which at the same time was producing its full and proper yield of grass, it was found that 61 tons per acre was the actual crop carried. Therefore, supposing that all the fifty-five and a half acres had been of equal standing, and sown at the same time, the total yield would have been 3250 tons of grass, or about 1 ton of grass for every 100 tons of sewage, and supposing 750 tons are deducted as the natural yield of the same land under ordinary circumstances. Cow feeders, and others, give 15s. to 20s. for this grass cut and bound, so that the produce of each acre would be from £40 to £60. The laying out and drainage costs from £5 to £15 per acre, thus, inclusive of very heavy charges for labour and machinery, there remains a large margin for profit.

The mangold was sown in May, and taken up in October, having been sewaged at the rate of 1100 tons per acre. The crop averaged fifty tons per acre, doubling the yield on another part of the farm where the land was equally good, and had received twenty tons cow-house dung and five hundred weight of mixed guano, superphosphate, and common salt, per acre. All the other crops mentioned turned out very well, many carrying off prizes at the Royal Agricul. Inst. Christmas Show at Islington. The sugar beet had a higher saccharine value than any produced in England; the strawberries took the second prize at the Royal Hort. Society Show in June, 1867: the three or four acres thus planted were a wonderful sight, the berries being of enormous size and in the utmost profusion. In wheat, a dressing of 500 tons per acre produced a crop of forty-three bushels per acre, with four and a half loads of straw, whilst contiguous land under ordinary conditions bore twenty-nine bushels with three loads of straw. The cabbages also did well, being planted in August and sold in October, at £10 per acre, on the ground.

The author is indebted to Mr. J. C. Morton, the eminent agriculturalist, who had the general supervision of the farm, for some of the above figures.

Sewage irrigation carried on under the circumstances above mentioned was therefore a decided success, but it would be a mistake to suppose that all these results were due exclusively to the manurial properties contained in the sewage. It has been proved in many parts of the world, that pure water used

at the proper times, and under proper conditions of soil and climate, has a wonderfully beneficial effect upon vegetation, so that the above results must be modified, if a true value of sewage as a manure is to be deduced.

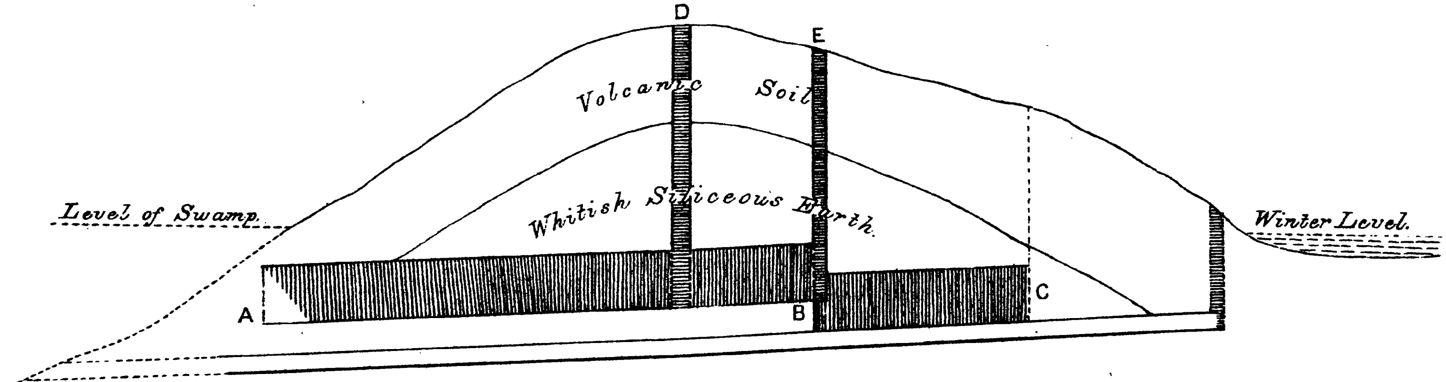
Before closing the subject, there are still some observations to be made upon the theoretical value of sewage, and upon the effects of its use as a manure, upon the health of those living in contiguity to sewaged land.

By an average of the analyses of several of the most distinguished chemists it has been found that 200 oz. of ammonia are voided annually by an individual, ⅞ths of which exists in the fluid matter of sewage, whilst the average amount found in one gallon of sewage varies from 9·7 to 3·91 grains, according to the water supply. This represents a composition in which 1000 tons of sewage is equivalent in ammonia to from 16 2-5ths to 6 4-5ths cwts. of guano. Taking guano at 13s. a cwt., the value of sewage varies from 2·44d. to 1d. per ton. At Barking, from one hundred tons of sewage were derived one ton of grass, of a value of from 15s. to 20s., which would give the practical value of 1·8d. to 2·4d. per ton, thus approximating, in a striking manner, to the theoretical values.

As regards the sanitary points in such a system, it might be reasonably expected that the continued pouring out of such vast quantities of rapidly fermenting manurial matter, the earth would by degrees become saturated, and refuse longer to carry out the powers of deodorization with which nature has endowed her; such, however, is the case in very rare instances, as it is usually hard to detect any effluvium whatever, and that which exists has nothing particularly disagreeable in its character, being merely like a concentrated essence of soap-suds. This may be partly owing to the extreme dilution, and the absence of any solid matters in the sewage, by the time it arrives at the outfalls, and the rapidity with which it finds itself on the soil before fermentation has set in, and whilst it is in the most fitting state for absorption by the growing crops. In fact, in the sewers and reservoirs themselves, after the first day or two, little inconvenience is experienced whilst the superintendent of the lower part of the sewers frequently has to take a walk of some miles up and down the sewers, or a stroll through the reservoirs, before breakfast, without being a bit the worse for it. Upon the tops of both the Barking and Crossness reservoirs are several labourers' cottages, where no illness has resulted; and at the time of the last cholera attack in London, some hundreds of men were drafted down into the author's works from the Isle of Dogs' sewer, where several had died, and a panic had arisen. There was not, however, a single fresh case after their removal, though there were many of them daily in probable contact with millions of so-called choleraic germs. It may, therefore, be fairly assumed that no evil effects can result from the use of sewage as a manure, always supposing that it is sufficiently diluted, sufficiently fresh, and sufficiently disintegrated by its passage through the sewers. Also that Italian rye grass is the crop to which it can be most economically applied in large quantities; the more particularly, as the land upon which it is grown must be re-broken up every three years, so as to ensure a full crop.

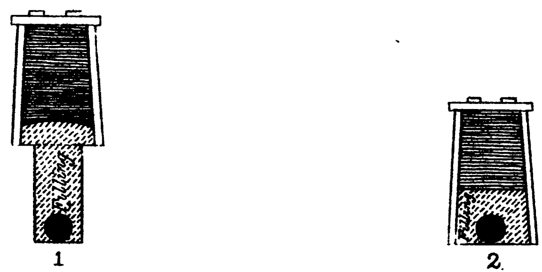
This periodical stirring would also have the effect of preventing the soil becoming too sodden, or giving rise to the generation of noxious gases.

This paper has been written with a view to lay before the meeting a slight sketch of the value of a system of Main Drainage, which shall ensure a small return to ratepayers upon any sums expended by them in behalf of the health of the general public, as well as to show the value of sewage irrigation generally, where the produce can command a ready market.



LONGITUDINAL SECTION.

Hor: Scale 50 ft to 2/3 of an inch.
Vert. " 10 " " "



Scale 5 ft to 2/3 of an inch.

TRANSVERSE SECTIONS.

TO ILLUSTRATE Paper on the DRAINAGE of the REMUERA SWAMP by J. Baber.

J. Baber del. J. Buchanan lith.

Printed at the Gen. Gov. Lith. Press by J. Earle.

ART. LIII.—*On the Drainage Works at Remuera Swamp.* By J. BABER, C.E.

(With Illustrations.)

[*Read before the Auckland Institute, November* 15, 1869.]

THE means for draining the swamp near the Remuera sale-yards, known as Mr. Farmer's swamp, have been provided by laying earthen pipes in a tunnel in a different manner from the ordinary mode. The area of the swamp is twenty acres, in winter it had about three feet of water in the lowest parts. The greatest depth of the drain now laid is twenty-eight feet below the surface of the ridge. The diameter of the pipes used is thirteen inches.

In designing the work, care had to be taken, that the pipes, after they were laid, should be secure from accident or displacement, from any slipping of the feet of the upright timbers, and that sufficient room should be left for working, without taking out more earth than was necessary. The strata through which the drive was cut consisted of a red volcanic soil, varying from eight to ten feet in thickness, overlying a bed of white silica and alumina almost destitute of cohesion, falling in from behind the timbers in thick flakes, without warning. The transverse Section 1 (See Plate 13) shows the working: the tunnel being first driven and timbered to a convenient length, a trench two feet wide, and four feet deep, was sunk in the floor of the drive, in this the pipes were laid, and the earth thrown on them as the trench was dug. The floor of the drive was thus raised about nine inches, and the feet of the uprights secured from slipping, while sufficient headway was left above, both for levelling and trucking out the earth from the drive. This plan was continued for about 220 feet, when the white sandy bed became so treacherous, that it was no longer safe to trust to the footing of the uprights, which slipped inwards as soon as the strainers were moved, and the digging the trench commenced. For a short distance Section 2 was used; it was safer, but did not afford the same facilities for keeping the correct gradient, nor for removing the earth.

The longitudinal section shows the tunnel from A to B, driven according to Section 1, and its continuance from B to C, according to Section 2, the remainder was laid in an open cutting. The shaft D is permanent, in order to inspect the work at any time without much cost, that at E is a working shaft, filled in at completion. The timber uprights and headers are left in the drive, allowing the earth to fall gradually in upon the earthen pipes. The work was executed in a bad season of the year, in the months of May, June, and July. It cost £222 11s. 6d., or rather more than £1 14s. a yard. The pipes were socket pipes, glazed inside and out, manufactured by Carder, of Henderson's Creek.

Like other swamps in the volcanic parts of this district, this one had its summer outlet through the lava, on the south-west side, which dried the swamp in summer, but in winter was insufficient to carry off the water that came from the surrounding land. In the summer of 1868-1869, this outlet was enlarged, in the expectation that it might be rendered more effectual, this, however, did not prove to be the case. The water is now carried under a ridge, and thence to a volcanic cave, where it instantly disappears.

Art. LIV.—*On the Comparative Performances of certain* River Steamers, *on the Waikato.* By James Stewart, C.E., Inspector of Steamers, etc.

[*Read before the Auckland Institute, September* 20, 1869.]

During an official visit to the Waikato, a few months ago, I was enabled to collect pretty definite particulars of the comparative performances of side paddles and stern wheel, as applied to the steamers "Blue Nose" and "Rangiriri." Two vessels differing widely in construction, and, as the investigation proves, just as much in effective results of the applied steam power. I have worked the comparison in various points, and now take this opportunity of laying the same before the Institute, feeling assured that it will prove of interest to many.

The construction of these vessels is known to all who have been interested in the Waikato during the last five years. The "Blue Nose" is a wooden vessel, propelled by side paddles of the common sort. The "Rangiriri" is an iron vessel, with a single feathering paddle wheel at the stern. The "Blue Nose" is moderately fine in shape, while the other is hideously bluff at the bows, straight in the sides, and square in the stern. Both vessels have direct-acting, high-pressure machinery, and nearly the same draft of water, but with these similarities their points in common cease, and a wide divergence on all others takes place, the particulars of which are the subject of this paper.

In comparing the vessels, it will place the matter more clearly, if the various points are tabulated as under.

POINT OF COMPARISON.	"BLUE NOSE."	"RANGIRIRI."
Ratio of beam to length .	1 : 6·3	1 : 4
Immersed midship section	40 sq. ft.	55 sq. ft.
Cylinders . . .	$13\frac{1}{8}$ in. × 2 ft. 4 in.	$11\frac{1}{2}$ in. × 2 ft. 3 in.
Steam pressure during trial	56 lbs. per sq. in.	51 lbs.
Revolutions per minute .	28	25
Computed indicated h. p.	53	31·5
Speed per hour . .	6·5 knots	6 knots
Paddles . . .	Common	Feathering
Effective diameter of wheel	10·7 ft.	9·2 ft.
Slip of wheels . .	30 per cent.	17 per cent.
Ratio of immersed floats to immersed midship section	1 : 1·9	1 : 2·4

It will thus be seen that, notwitstanding the very great advantages in point of build, power, etc., the "Blue Nose" only attained a very small increase of speed over the "Rangiriri." To put the comparison more clearly on this point, let the usual Admiralty formula be taken to fix the value of the constant of efficiency, premising that for vessels of similar build, the larger the constant, the greater is the useful effect of the power applied. This rule is $C = \frac{V^3 S}{H P}$ in which C is the constant, and V the speed in knots per hour; S the area of immersed midship section, and HP the indicated horse power. Reducing from the above values of those signs, we find for the "Blue Nose" C = 207, and for the "Rangiriri" C = 377. The result is sufficiently startling, and in great part must be accounted for by the faults of the "Blue Nose," although I have been aware, ever since the "Rangiriri" was placed on the river, that the stern wheel developed more useful effect than the side wheels. But I never had an opportunity, until lately, of fully comparing them.

Before attempting to give a reason for the above result, I will mention

another circumstance which has long been remarked on the Waikato. When a stern wheel boat enters shallow water, the engines move slowly and appear to drag with difficulty; while if a side paddle vessel of like draft of water enters the same part of the river, the engines get away very much *faster*. The speed of the *vessel* being in both cases somewhat lessened, in proportion to the shallowness of the water. The explanation of this, no doubt, lies in the same path as that of the comparative useful effect of tho stern wheel above noted, and also with that of the phenomenon of negative slip of screw propellers.

In the case of screw steamers, the paradoxical result of the vessel being propelled through the water faster than the advance of the propeller, has often claimed serious thought; and in all single-screw steamers the positive slip is very small, as compared with paddles. Many ingenious theories have been propounded in explanation, but the one now generally held to be the true one, applies, I believe, equally to the explanation of the case in point. When a vessel moves at some speed through the water, skin friction must necessarily impart motion to a sheet of water under and around the hull. The water in contact with the hull having nearly the same velocity, and lessening in proportion to its distance from it. There must then be a sheet of water having a mean thickness, and an average velocity, which cannot be at once brought to rest, but must follow up the vessel, and gather in a column of moving water having some ratio of speed to that of the vessel. In this column of moving water, the screw works, and as the velocity of this may in some instances be greater than the positive slip of the screw, the result is apparent negative slip. In the case of a flat vessel like the "Rangiriri," the stern wheel moves in a moving sheet of water, which has the same result of giving back part of the power expended in putting it in motion; which power is entirely lost to side paddle vessels, and also, in a great extent, to twin screws, hence the great observed slip of those, as compared with a single screw. The effect of shallow water above referred to, is, no doubt, traceable in great part to the same source.

I have thus endeavoured to make clear the observed results of the two systems of applying power in paddle vessels, but in doing so, I must not be understood as advocating for river steamers, stern wheels as preferable to the ordinary method, unless in very exceptional circumstances. There are constructional disadvantages attending the design of such vessels, which are serious, while the uncertainty of steering in shallow water, the impossibility of using disconnected paddles, and thus steering without way on the vessel in shallow water, make, even for a tortuous narrow river, a stern wheel vessel, unadvisable. Neither must the effective results of the "Blue Nose" be taken as an instance of those of side paddles, as with her general form, and small immersed sectional area, the constant of efficiency ought to be nearly equal to that of the "Rangiriri," which would then, with everything considered, still leave a balance in favour of the latter.

ART. LV. — *On the earlier* EARTHQUAKE WAVES *observed on the Coast of New Zealand.* By C. DAVIE, Chief Surveyor, Province of Canterbury.

[*Read before the Philosophical Institute of Canterbury, November* 4, 1868.]

THE vast extent of ocean over which tidal disturbances extended, caused by the late earthquakes along the coast of South America, have invested this subject with a degree of importance which they did not before possess, especially to those of us who live along the east coast of New Zealand. The object of the present paper is to place on record certain facts in connection with similar occurrences, which have been noticed in this country, in order that by degrees, as other facts shall, from time to time, be brought together, some light may possibly be thrown on the causes and effects of these remarkable phenomena.

The first great earthquake in New Zealand, of which we have any certain record, appears to have been that which occurred in October, 1848, and which was felt from New Plymouth to Wellington, and possibly at Auckland. In the South Island it extended from Nelson to Otago; but it does not appear to have done much damage excepting at Nelson and Wellington. This earthquake was felt at sea by a vessel, the "Sarah Ann," at some distance to the north of Cape Farewell. No tidal disturbances appear to have been noticed.

Previously to this, in February, 1846, Mr. Hamilton, on a voyage from Auckland round Cape Horn, when about 1500 miles east of New Zealand, experienced a sharp shock of earthquake: the ship "David Malcolm" was in deep blue water, but she vibrated from stem to stern; some of the passengers supposed they were grating over a ledge of rocks.

The next great earthquake occurred on the 23rd January, 1855, and was felt over the greater part of the northern and southern islands of New Zealand; this again was felt most severely at Wellington, at which place Commander Drury, of H. M. S. "Pandora," was anchored; I give extracts from his account of what occurred.

"At 11 minutes past 9 p.m., the north-west gale still blowing strong, we felt suddenly an uncommon and disagreeable grinding, as if the ship was grating over a rough bottom. It continued with severity for more than a minute; the ship slewed broadside to the wind. We were in 6 fathoms at the time.

"Lieut. Jones and myself immediately landed, we found the tide alternately ebbing and flowing. The gun at the flagstaff was turned over. The elemental wave proceeded from W.N.W. to E.S.E. There was no apparent disturbance of the barometer, or any apparent connection between the gale and the earthquake: we had however every reason to believe that the latter had immediate local influence on the atmosphere, producing violent gusts after the shocks. If it is a fact that the firing of artillery, or bush-fires, will produce a local calm by the disturbance of the atmosphere, the phenomenon here may be more easily accounted for. But a more interesting and extraordinary phenomenon occurred,—I say extraordinary, because no person appears to have noticed it in the earthquake of 1848; for eight hours subsequent to the first and great shock the tide approached and receded from the shore every twenty minutes, rising from 8 to 10 feet and receding 4 feet lower than at spring tides. Our ship I heard was aground four times at her anchorage. The ordinary tide seemed quite at a discount, for the following day, the 24th, it scarcely rose at all. On the 25th we weighed for Nelson, and felt one shock in 26 fathoms, off Sinclair Head (exactly the same feeling as when at anchor), and a slighter shock, in 80 fathoms, off Queen Charlotte's Sound."

At Nelson the shocks appeared to come in a N.E. direction. At Canter-

bury, where the shock was severe, no damage whatever was done; nor do I believe that any tidal wave was noticed on the sea coast. A wave, however, came up the Avon to within two miles of Christchurch. I was at the time living close to the river, and heard the rushing sound of the water; I did not however know what it was until the next morning when I noticed that the river weeds had been washed on to the grass, for about one foot in height. It may be worth recording that a heavy rain from the north-west fell on the day of the earthquake; this is a very rare occurrence in the neighbourhood of Christchurch.

It is worthy of notice that earthquakes happened along the coast of South America at the same time, and were felt by different ships at sea in the neighbourhood of New Zealand. The earthquake waves in Palliser Bay were about 30 feet high, and showed a white crest although the night was cloudy; they succeeded the shocks. One family would certainly have been drowned had not some sailor, who had been on the South American coast, recognized the character of the approaching wave the moment it became visible.

A remarkable wave was observed some time during the month of March, 1856, by Mr. Michael Studholme, who happened to be near the beach at the mouth of the Waiho river. He saw the wave at some distance in the offing, approaching from a south-easterly direction; it was many feet in height and broke with great violence on the beach, washing over into the lagoons which there line the shore; shortly after, on riding towards Timaru, he noticed the effects on the beach at different places. It does not, however, appear to have been noticed by any one at Timaru.

I happened to be at Akaroa some day during that month, and whilst engaged in surveying near low-water mark, was surprised to find the water suddenly rise, which it continued to do for some minutes, and then again began to ebb. I remember mentioning it at the time to some of the inhabitants of Akaroa, but not thinking of earthquake waves we attributed it to a change of wind in the offing sending in the tide before the proper time. This supposition would not, however, account for the ebb again commencing, and I now believe it was the same wave noticed by Mr. Studholme.

The recent earthquake waves have been so fully and ably reported upon by Captain Gibson, and our learned president, Dr. Haast, that it is not necessary for me to add anything to their observations.

Art. LVI.—*On a series of Tables for facilitating the Calculations of Altitudes from Barometrical Observations in Mountainous Countries; with explanations.** By E. Dobson, C.E., Assoc. Inst. C. E.

[*Abstract, by the Assistant Secretary, of Paper read before the Wellington Philosophical Society, November* 13, 1869.]

The author commenced by explaining, that in the year 1865, when engaged in exploring the Canterbury Alps, for the purpose of finding a route available for the construction of a coach road, between the eastern portion of that province, and the then newly-discovered goldfields on its western coast, the necessity for such tables as he proposed to describe had been manifest to him.

"The broken character of the country, and the denseness of the forests, which stretch everywhere from the banks of the rivers up to the line of

* The valuable tables appended to this paper, not being suitable for insertion in this volume, have been returned to the author for separate publication in a convenient form for the use of engineers.—Ed.

perpetual snow, would have rendered futile any attempt to obtain a connected series of levels by the use of the spirit level, and therefore not only the trial levels, but those required for the location of the selected route were calculated from barometric observations.

"As this, however, involved a great mass of calculations, the author was led to consider whether the reductions of the barometer observations could not be effected by simpler means than those commonly used. It then occurred to him that if the altitude corresponding to any reduced barometer reading were divided by the difference in the height of the mercurial column at the sea level, and at the given altitude, the resulting quotient would be a factor, which might be used for calculating approximately the altitudes corresponding to other barometric readings within a certain limited range.

"Thus, assuming the height in inches of the mercurial column at the sea level = 30,

And taking a series of reduced barometric readings as . .	29	28	27	26	etc.
The differences between these readings and that at the sea level are . . .				4	etc.
And the corresponding altitudes at a mean temperature of 32° Fah. . . .	ft. 886·9	ft. 1804·8	ft. 2756·2	ft. 3743·5	etc.
Which altitudes divided by the differences of pressures would give the factors .	886·9	902·4	918·8	935·9	etc.

which could be used for calculating approximately the altitudes corresponding respectively to the barometer readings between 30 and 29, 29 and 28, 28 and 27, 27 and 26, etc.

"Following up this idea, it further became apparent, that as the differences of mercurial pressure are expressed in inches and decimals, the decimal division of the differences between these factors would supply the means of calculating factors for all intermediate barometric readings, not, it is true, with perfect accuracy, but within limits of error which may be practically disregarded; the maximum error, from the employment of the factors in the calculations, in the resulting altitudes, for elevations under 3250 feet, not exceeding four inches.

"It will be seen at once, that in this system of calculating altitudes, the correction for the difference between the actual and the tabular mean temperature will be most readily made, not by reducing the barometer readings, but by correcting the tabular altitudes; and also that if each of the factors be divided by 480, the resulting quotients will give the constants by which they must be respectively altered, for each degree of difference between the actual and the tabular mean temperature. The result of the above considerations was the construction of the following table (calculated for a mean temperature of 32° Fah., and a mercurial pressure at the sea level of 30 ins.) by which the calculation of altitudes from barometric observations may be effected rapidly, and with the use of very few figures, without the necessity of referring to a table of logarithms, and with a corresponding diminution in the liability to numerical errors.

Reduced Barometer readings.	Difference in the height of the mercurial column, at the sea level, and at given altitudes.	Height, in feet, per inch of difference in the height of the mercurial column.	Corrections per 1 ° Fah. difference in temperature.	Altitudes, in feet, above the sea level.
inches.	inches.	feet.	feet.	feet.
26	4	935·9	1·9	3743·5
		{ Diff. 17·1		
27	3	918·8	1·9	2756·2
		{ Diff. 16·4		
28	2	902·4	1·9	1804·8
		{ Diff. 15·5		
29	1	886·9	1·8	886·9
		{ Diff. 14·9		
30	0	872·0	1·8	Sea level.

"The table in the above form having proved of great service in the author's professional practice, it has been extended for publication, by calculating the altitudes for every hundredth of an inch difference in the height of the mercurial column, from 30 inches to 26 inches; and a column of temperatures has been added, which will be found of considerable assistance in calculating the difference between the actual and the tabular temperature at any given altitude."

Mr. Dobson then proceeds to give the principles upon which the tables are framed, at greater length; with full explanations of the tables themselves, directions for registering the observations, and for using the tables in the calculations of altitudes.

A chapter is devoted to "General Observations," in which he states that, "in tolerably level country, and in clear, calm weather, the observations may be extended to a distance of from fifteen to twenty miles from a well-ascertained bench-mark without risk of serious error. If, however, there is much wind, not only must these limits be greatly reduced, but it will be advisable that the observations at each of the upper stations should be twice repeated at ten minutes intervals, in order that it may be ascertained whether the barometer is rising or falling, and that the index error may be adjusted according to the directions whence the changes come.

"It must, however, be remembered that the fluctuations of the barometer due to variations in the quantity of aqueous vapour in the atmosphere, as well as to other causes, are so great as to render all barometric observations valueless, as engineering data, which cannot be corrected for the deviations from mean atmospheric pressure, by comparison with a register kept at some neighbouring station, of which the altitude has been ascertained."

The author suggests that "although the mercurial barometer should always be used, when practicable for the observations at permanent meteorological stations, it is at once too cumbrous and too fragile for the rough work of a reconnaissance survey. For this purpose a properly compensated aneroid barometer may be substituted, with advantage, for the more perfect instrument. Up to the present time, the use of the aneroid barometer has, with trifling

exceptions, been confined to forecasting the weather, the somewhat intricate nature of barometric calculations, having prevented its general adoption as an instrument for taking levels. It is hoped that these tables, by removing the difficulties referred to, will pave the way to a more extended use of this valuable instrument which is especially adapted for taking trial sections in wooded and mountainous districts, and with which, under proper management, very close results may be obtained, without that expenditure of time and money, involved in the use of the spirit level under such circumstances."

ART. LVII. — *The earth of New Zealand, a bad Conductor of Electricity, as compared with that of other countries.* By F. E. WRIGHT.

[*Read before the Philosophical Institute of Canterbury, September* 1, 1869.]

MY attention was first attracted to this subject under the following circumstances :—

In March, 1867, I had occasion to visit Hawkswood, in the Nelson Province, and I returned to Christchurch viâ the Cheviot Hills, following the line of telegraph all the way back. Between Hawkswood and Glenmark I saw that a large number of the telegraph poles were lying on the ground ; they were birch saplings, and most of those still standing appeared to be so badly rotted at the point of their emergence from the soil, that I have but little doubt many more fell during a south-west gale which detained me two days at Mr. Moore's station. I need hardly state that the poles for the whole of the distance, here referred to, have been replaced by others of a more substantial character.

Under these circumstances, on arriving at Christchurch, I felt it almost useless to ask at the Telegraph Office, if the line was open to Wellington, and was greatly surprised to find that messages could be forwarded. This was at variance with my previous knowledge of the subject, and I thought it so curious and exceptional, that I have since lost no opportunity of enquiring into the matter, the result of which has been a settled conviction on my mind, that an altogether anomalous state of the soil, so far as its conductibility of electricity is concerned, obtains in these Islands.

Mr. de Sauty, the late electrician of the telegraph department, who is quoted as an authority in several recent works on telegraphy, and who had been engaged on telegraph lines in various parts of the world, assured me that he was unaware of any other country or place exhibiting similar characteristics.

Mr. Bird, the present Provincial Inspector of Telegraphs, informed me, a year or two since, that were the conditions of the earth as a conductor of electricity the same here as in Europe or America, it would have been quite hopeless, for months together, to have endeavoured to send a telegraphic message in any direction from Christchurch, there being faults in all the lines, which would have proved sufficient to destroy the connection in any other place but New Zealand.

Mr. Meddings, attached to the Telegraph Office in this city, who takes the greatest personal interest in his vocation, and works at it with a zeal which may be termed enthusiastic, has made many interesting experiments on the subject. He tells me that he finds the greatest difficulty in getting a good *dead earth* in Christchurch, or in fact in any part of New Zealand to which he has been called by his employment.

This anomalous state of the earth in this country was at first to some extent accounted for, in my mind, by the dryness of the soil, thinking that the

absence of moisture on the plains might render the ground a bad conductor; but I have since learned from Mr. Mason, the gentleman at present in charge of the Telegraph Office here, that in some of the very driest districts of Australia, it is only necessary to force a small iron bar a few inches into the ground, effectually to disperse any electricity which might be conducted to it; whereas in Christchurch, where, a foot or so from the surface, the ground is at all times moist, an earth plate of the size ordinarily used in England disperses the electricity in a very imperfect manner.

Mr. Meddings, in one instance, connected the wires with the pipes of an artesian well from which the water was flowing, and it proved a very imperfect dead earth for the electricity conducted to it. He also experimented on a telegraph line forty-one miles in length, in the Province of Hawke's Bay, with the following results. He generated the electricity at a point about a mile from one of the extremities of the line, which was connected with the earth by wires and earth plates, at this point, as also at the nearest extremity. This under all ordinary states of the earth in other parts of the world, would, I am led to believe, at once have disposed of any current of electricity sent along it; in place of which, however, the electricity was resisted by the earth at each of the places where it was connected with it, and was forced to the more distant extremity. At the Cheviot Hills Station, which is provided with an ordinary earth plate, a considerable portion of the electricity finds its way to Christchurch, when it should be absorbed in the earth at the station.

I must ask your indulgence for the crude and superficial character of this short paper, but I trust that the subject which I have thus had the temerity to bring under your notice, may lead to its investigation by others more able to expend time, and bring knowledge and requisite appliances to its elucidation.

Art. LVIII.—*On the Mechanical Principles involved in the Flight of the Albatros.** By Captain F. W. Hutton, F.G.S.

[*Read before the Auckland Institute, June* 1, 1868.]

Perhaps no subject in ornithology has been less satisfactorily treated than that of flight, although it possesses very great interest, both for the naturalist and the mathematician. It is, however, one of considerable difficulty, as it has to deal with the complicated question of the resistance of the air to bodies moving with variable velocities; and the following remarks do not pretend to do more than indicate the principles involved in the flight of the albatros when sailing along without moving its wings.

I must premise, at starting, that I take it for granted that no movement of the wings, body, or feathers of the bird takes place other than those necessary for seeking its food, or altering its direction of flight, as all observers are agreed on this point. It may also be necessary to remark that the velocities spoken of are velocities of the bird through the air, and not over the water, which might be very different. For example, suppose an albatros to be flying with a velocity of 40 feet a second, against a wind having also a

* This, and the following paper on "Sinking Funds" (Art. LX.), had to be reserved last year, for want of the necessary algebraic type: they are now printed, together with a reply by Mr. J. S. Webb, to Captain Hutton's paper on the "Flight of the Albatros." As it was still found impossible to procure all the mathematical signs, the following substitutions have been made throughout:—

For Greek *Beta* the letter F has been inserted,
" " *Theta* " I " " "
" " *Phi* " Q " " " —Ed.

velocity of 40 feet a second ; it is clear that the bird would remain stationary with regard to the sea over which he was flying, nevertheless he would have a velocity of 40 feet a second through the air, just as much as if the day was quite calm, and he was flying both through the air and over the water equally at the rate of 40 feet a second. This being understood, I will first suppose an albatros, on a perfectly calm day, to be placed in the air at some distance above the sea-level, with its wings and neck stretched out in the attitude of flight, but without any forward movement. It is clear that the moment the support was withdrawn, it would commence falling in a nearly vertical direction, unless, indeed, it had power to buoy itself up by inflating its air-cells with hot air. That it has not this power I have elsewhere shown (See "Ibis," July, 1865), but for the sake of completeness I may perhaps be allowed to repeat it here. "The temperature of the albatros, as taken by Sir G. Grey, by placing a thermometer under the tongue, is 98° F., and if we add 10° F. to this, in order to allow for the difference between the head and the body, we shall have the temperature of the air-cells at 108° F. The temperature of the surrounding air cannot be taken lower than 48° F. ; the bird, therefore, could not raise the temperature of the air taken into these cells more than 60° F. This would increase its volume not quite one eighth ; and taking 100 cubic inches of air to weigh 31 grains, and the average weight of an albatros to be 17 lbs., it would be necessary, in order that the specific gravity of the bird might be brought to that of the atmosphere, that these cells should contain 1820 cubic feet of air, or in other words, they must be more than 1000 times the size of the body of the bird. In fact it would require a sphere of more than 15 feet in diameter to contain the necessary quantity." This objection being disposed of, it follows that the bird must fall.

If now we take the area of the under surface of the body, neck, and expanded wings and tail of the albatros to be 8 square feet, and its weight 17 lbs., we see that it would take an upward pressure of 2·12 lbs. per square foot, to support it. This pressure would be given by a current of air moving upwards with a velocity of 20 feet a second, so that on a perfectly calm day the bird would fall downwards at a constantly increasing rate, until it had attained a velocity of 20 feet a second, which velocity it would keep until it fell into the sea. This is called its "terminal velocity."

It is necessary to notice that as the position of the body, wings, and wing-feathers of the bird would be inclined to the horizon, the direction of descent would not be quite vertical, but would be inclined in the same direction as the body and feathers of the bird, namely, backwards.

I will next suppose that instead of being calm, a breeze is blowing with a velocity of C feet a second. The bird would now, of course, be forced back in the direction of the wind at the same time that it was falling. But it is well-known that when a body at rest is set in motion, by a force acting upon it, the body commences to move gradually, and acquires a certain velocity in a certain time which is represented by the formula

$$v. = \frac{P.g.t.}{W} \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where v. is the velocity acquired in the time t., when a force P. acts upon a body weighing W. lbs., g being the force of gravity. This is called the "inertia" of the body. If then we suppose the bird to be facing the wind, the backward velocity, communicated by the wind would increase, while the force of the wind upon it would decrease, but of course P + v would always be equal to C.

$$\therefore v = C - P. \quad . \quad . \quad . \quad . \quad . \quad (2)$$

combining these two equations we get

$$t = \frac{W (C - P)}{g P}.$$

now when the velocity of the bird equalled that of the wind, P. would be o, in this case

$$\therefore\ t = \frac{C W}{o} = \infty$$

so that the bird could never actually acquire a velocity equal to that of the wind, and there would always be a force of $C - v$. acting on it, and as the bird, its wings and its feathers, would be inclined at an angle, which I will call Q, to the horizon, and therefore to the direction of the wind, this force would be resolved into two—one, equal to $(C - v) \sin^2 Q$, tending to drive it backwards—and the other, equal to $(C - v) \sin Q \cos Q$, tending to delay its fall or even to raise it, supposing it to be sufficiently great to overcome the force of gravity. But even in this case $C - v$. is constantly decreasing as it approaches its limit $v = C.$, so that there must always come a time when $(C - v) \sin Q \cos Q$ is not sufficient to support the bird, and it must commence to fall; so that in all cases it would reach the water in a curved line at a certain distance behind the first position of the bird, the form of the curve depending on C., W., and Q. I have dwelt thus minutely on these simple facts, because it has been supposed that in a gale of wind, a certain position merely of its wings or feathers, might enable an albatros to sail *against* the wind, without any momentum of its own, which is quite impossible.

Another explanation that has been given is that the albatros can fly *almost* against the wind, in the same way that a ship beats to windward. This, however, is manifestly incorrect. A ship is placed in two different media, one of which—the water—is practically stationary, and it is enabled to sail at an acute angle with the wind, because the pressure of the wind, being met by the resistance of the water, is resolved into forces having other directions, and advantage being taken of this by trimming the sails, it ultimately results that the ship is moved in the direction of least resistance, viz., forwards. But the case of the albatros presents no analogy to this; it is placed in one medium only—the air, the whole of which is moving in the same direction, and with the same velocity, and it has no means, unless by using its wings, of offering any resistance, except its inertia which we have already seen is not sufficient, to the wind and so resolving its direction into others more advantageous to itself, in fact it is analagous to a balloon, which, except by the aid of machinery, can only drift with the wind.

Having, therefore, seen that while the wings are stationary, no forward movement can be commenced by the bird, we are forced to the conclusion that the albatros sails along by means of the momentum that he had previously acquired by strokes of his wings on the air, or of his feet on the water when rising from it, or from both combined, and that so soon as the resistance of the air has reduced his velocity so much that it no longer prevents him falling, fresh impulses of the wing have to be given. It will now be observed that the difficulty has been shifted from the means of obtaining motion through the air, to that of keeping up a velocity but slightly diminished, for so long a time as the albatros is known to sail without using his wings, or in other words, to the very small resistance that the air must offer to his progress; and if it could be shown that this resistance is not too great to allow for the longest observed time of sailing, all difficulties with respect to this part of the flight of the albatros would disappear. I do not profess to have done this, but I think that I can show that there is no insuperable difficulty in the way.

Suppose now the body of the bird to be inclined at an angle Q to the horizon, and moving through the air with a velocity of v. feet a second, it would rise (omitting the force of gravity for the present) by the angle at which it was flying V. tan Q feet a second, and the resistance of the air to its wings would give it a further upward movement of v sin Q cos Q feet a second, so that the total rise of the bird would be v (tan Q + sin Q cos Q) feet per second; but we have already seen that the terminal velocity of the bird is 20 feet a second, so that in order to find the velocity at which the albatros must fly at an angle of Q to the horizon in order to make the upward movement just sufficient to counteract the force of gravity, or in other words to maintain a horizontal line of flight, we have

$$v\ (\tan Q + \sin Q \cos Q) = 20$$

$$\frac{20}{\tan Q + \sin Q \cos Q}$$

$$= \frac{20 \cos Q}{\sin Q\ (1 + \cos^2 Q)}$$

If we take Q to be 5°, we shall find that v = 116; and if we take it to be 10°, we get v = 58. It appears, therefore, that if an albatros starts with a velocity of 116 feet a second, while sailing at an angle of 5° to the horizon, he could maintain a constant height above the sea level until his velocity was reduced to 58 feet a second, by gradually increasing the angle at which he was flying to 10°.

I will now compare the actual known resistance of the air to a round shot, to what ought to be the resistance to an albatros to allow it to sail for half an hour without using its wings, and only reducing its velocity from 116 feet to 58 feet per second.

The formula for calculating the resistance to round shot as given by Parcelet, is

$$R = 0{\cdot}0006\ A\ v^2$$

where A is the resisting area in square feet.

If now we take the area offered to the air by the front surface of the bird to be 0·66 square feet, and its mean velocity at 87 feet per second, we have by the round shot formula

$$R = 0{\cdot}0006 \times 0{\cdot}66 \times 87^2$$

$= 3$ lbs. nearly, which is evidently too great.

I will now estimate roughly the real resistance the albatros ought to have met with in order to enable it to sail for half an hour.

Taking the average velocity at 87, it is evident that in half an hour it would traverse 156,600 feet. Now at starting it would have accumulated

$$\frac{W}{2g}v^2 = \frac{17 \times 116^2}{2 \times 32} = 3599 \text{ units of work,}$$

at finishing it would still have unexpended

$$\frac{17 \times 58^2}{2 \times 32} = 900 \text{ units of work.}$$

So that substracting one from the other, 2699 units of work have been consumed in going 156,600 feet, and the resistance overcome would be 0·017 lb. per foot, or only $\frac{1}{176}$ of that calculated by the round shot formula. This, how-

ever, gives rather too small a result, as the average velocity must be under 87 feet a second, and I will try a more correct way of arriving at the result.

Let w be the weight of the bird in lbs., V its velocity at starting, and v its velocity after having sailed over s feet in t seconds; and let v′ be its velocity after having sailed over s′ feet in t′ seconds.

If now we suppose the time between t′ and t to be very short we may assume the resistance of the air to be constant throughout the small space s′—s, and to be equal to $x\,Av^2$.

Therefore
$$\frac{W}{2g}v^2 = \frac{W}{2g}v'^2 + x\,Av^2\,(s'-s).$$

$$\frac{W}{2g}\,(v'^2 - v^2) = -x\,Av^2\,(s'-s)$$

$$\text{Or, } \frac{W}{2g}\cdot\frac{dv^2}{ds} = -x\,Av^2$$

$$\therefore \frac{dv^2}{ds} = -2\,Fv^2$$

where F represents $\frac{g\,Ax}{W}$.

$$\therefore v^2 = Ce^{-2Fs}$$

Now when $s=o$, $v=V$ $\qquad \therefore C=V^2$

And we obtain $v^2 = V^2\,e^{-2Fs}$

$$v=Ve^{-Fs}$$

$$e^{Fs} = \frac{V}{v}. \qquad \ldots \qquad (1)$$

But when the time is very short we may suppose that the velocity of the bird would remain the same throughout it, and therefore

$$s'-s=v\,(t'-t)$$

$$\text{Or } \frac{ds}{dt}=v=Ve^{-Fs}$$

$$\therefore FVt=e^{Fs}+c$$

Now when $t=o$, $s=o$ $\qquad \therefore c=-1$

And $e^{Fs}=FVt+1 \qquad . \quad . \qquad (2)$

Equating this result with that obtained in equation (1) we get,

$$\frac{V}{v}=FVt+1$$

$$F=\left(\frac{V}{v}-1\right)\frac{1}{Vt}$$

$$=\frac{V-v}{Vvt}$$

Substituting $\frac{gAx}{W}$ for F we have

$$\frac{gAx}{W}=\frac{V-v}{Vvt}$$

$$\therefore x=\frac{W\,(V-v)}{Vvtg\,A}.$$

Therefore in the case that we are supposing with the albatros

$$x=\frac{17\times 58}{116\times 58\times 1800\times 32\times 0{\cdot}66}$$

$$\therefore\ x=0{\cdot}000004 \text{ nearly.}$$

And the resistance to the bird would be

$$R=0{\cdot}000004\ Av^2$$

Which is $\frac{1}{150}$ of the resistance as calculated for round shot.

This difference seems very great, but several things have to be taken into consideration. In the first place the resistance obtained for the albatros is calculated on the supposition that both its under and front surfaces were planes, which is far from being the case. The under surface of the wings is concave, and perhaps offers three times the resistance of a plane surface, which would greatly reduce its terminal velocity, and therefore both the velocity at which the bird was compelled to fly in order to maintain its height above the sea, and the resistance offered to its forward movement. On the other hand the front surface is very well adapted for piercing the air, and as the resistance to a round surface is only about one-third of that to a plane, and to an elongated shot only one-sixth of that to a round shot, we might fairly presume that these two together might reduce the resistance to one-fiftieth part of that calculated for round shot.

Again we must remember that this result is obtained by supposing that the law, as determined for the velocities of round shot, holds good for lesser velocities, or that the resistance always decreases as the square of the velocity; but it is well known that this is not strictly the case even with high velocities, and it is probable that the law is very incorrect when the velocities, and shapes of the bodies, differ very considerably. For example, the range of an ordinary round shot starting with an initial velocity of 1200 or 1600 feet a second, can be pretty accurately calculated by the formula here used, but in the case of a mortar-shell, starting with an initial velocity of only 300 or 400 feet a second, the range is much better obtained by the parabolic theory, which omits the resistance of the air altogether, than by Parcelet's formula; and the velocity of the albatros is small, even when compared with that of a mortar-shell. The actual resistance of the air to the bird can only be determined by accurate experiments, and it is important that they should be taken, as until they are completed no satisfactory conclusion can be arrived at with respect to flight.

From the foregoing observations we can easily understand how it is that the albatros never sails for long in calm weather, for when no wind is blowing, its velocity over the water would be as great as that through the air, and it would have to rush along so fast that it could not search the sea properly for food, nor stop itself quick enough when it saw anything.

I have thus endeavoured to point out what appears to me to be the only possible way of accounting rationally for the wonderful flight of the albatros, but once more I wish it to be understood that I by no means pretend to have solved the problem, but only to have cleared the way for solving it.

Experiments are required for determining accurately the resistance offered both by the front and under surfaces of the albatros to different velocities of wind, and if I should ever be in a position to undertake these, I shall not fail to lay the results before the members of the Institute.

Art. LIX.—*On the Mechanical Principles involved in the Sailing Flight of the Albatros.* By J. S. Webb.

[*Read before the Otago Institute, November* 2, 1869.]

In the first volume of the "Transactions of the New Zealand Institute," there is an abstract of a paper by Captain Hutton on this subject, but for want of necessary type for the algebraic formulæ the paper could not be printed in full. A revised and modified copy of the more important portions of it has, however, been published in the "Philosophical Magazine" for August last. The subject dealt with by Captain Hutton is what has been, somewhat inappropriately, called the "Sailing flight of the Albatros"—that steady and continued motion, without any observable action of the wings, which has attracted the attention of every one who has made a voyage in the southern seas. The paper is ably written and very interesting, but in his mathematical treatment of the subject Captain Hutton has not been happy, having as it appears to me, made a mistake at the outset of his calculations. The object of the present communication is to supply what I consider to be the necessary corrections, and to show the effect which the new results thus arrived at have upon the general conclusions drawn by Captain Hutton from his own calculations. As I cannot ask this meeting to follow me through a dry, though by no means abstruse, process of mathematical reasoning, I have thrown that portion of the paper into the form of an appendix, which I lay on the table for perusal of those members who may be desirous of examining it.

In his paper* Captain Hutton proposes to himself "to determine approximately the probable resistance of the air in order to allow 'the albatros' to sail for half an hour without moving its wings." He estimates the under surface of the wings, body, and tail, at 8 sq. ft., and the weight of the bird at 16 lbs. From these data he concludes that "if an albatros starts with a velocity of 115 feet per second, it could maintain a constant height above the sea until its velocity was reduced to 64 feet per second, by merely increasing the angle to the horizon at which it was flying from 0° to 7°." He assumes that the wings are always inclined 15° more than the body of the bird. The corrections I offer to-day show that, on the data assumed, the velocity at starting must be 155 feet per second, instead of 115, and that it must not be reduced during the interval below 100 feet per second, instead of to 64 feet.

A consideration of the following extract from Captain Hutton's paper will show the bearing of this correction on his general results. "The velocity of the air in a 'fresh sailing breeze' is about 30 feet per second, in a 'moderate gale' 60 feet, in a 'strong gale' 90 feet, and in a 'great storm' 120 feet per second. Now, an albatros can often be seen sailing, though slowly, directly against a strong gale: his velocity" (through the air) "must therefore often be more than 90 feet per second. He is however most at home in a strong breeze or moderate gale, when the velocity of the wind is 50 or 60 feet per second, and consequently when his velocity would have to be 70 or 80 feet per second to enable him to fly easily against it. In a calm or light air, when the wind has a velocity of only 10 feet per second, the albatros rarely sails for so long as a minute at a time,—the reason for this being that as, in order to sustain himself in the air he must move through it with a velocity not less than 64 feet per second, he would even when flying against it have to travel over the sea at the rate of not less than 54 feet per second, or 36 miles an hour, and so could not reach it for good, or stop himself quickly enough when he saw anything; so that the velocity and manner of flight observed in the albatros correspond closely enough with those calculated as necessary from theoretical

* "Phil. Mag.," Vol. xxxviii., p. 130.—(No. 253, August, 1869.)

considerations." It will readily be seen that the very much higher velocities which I derive from Captain Hutton's data, upset the conclusion he has here drawn. It is however in the choice of his assumed data and in his calculations based on them, and not on the principle by which he accounts for the power of the albatros to sail for a long time without moving its wings, that Captain Hutton is in error. I do not know whether the merit of the demonstration belongs to him (he appears to claim it), but if so, notwithstanding the criticisms I have ventured upon, I willingly bear testimony to his success in the primary object of his paper, viz., to "indicate the principles involved in the flight of the albatros when sailing along without moving its wings."

Captain Hutton proceeds to calculate from his first results "what the resistance of the air to the forward progress of the albatros ought to be, to enable him to start with a velocity of 115 feet per second, and sail for half an hour without flapping his wings, and at the end of that time to have reduced his velocity to 64 feet per second." He arrives at a result for which he himself deems it necessary to offer excuses, viz., that the resistance to a body of the shape of this bird is only 1-300th of that to round shot. Had he used the figures which I have brought out, instead of his own, his estimate would have been only about half what it is,—a further proof, if any were needed, that the real details of the bird's flight are very different to those assumed in his calculations. I have not the necessary leisure to attempt to deduce these details from such physical data as are available by the aid of the undoubtedly true principle laid down by Captain Hutton. I repeat and endorse his own closing remark :—"the problem still remains to be solved; but until experiments have been made on the resistance offered to the air by the front and lower surfaces of birds, a tolerably accurate solution is not possible." I may add, that some careful observations of the duration of the "sailing flight" of various birds, and of their ordinary position in the air, whilst flying without flapping the wings, are absolutely necessary before anything like approximately correct calculations on the subject can be made.

APPENDIX.

The references in what follows are to the annexed copy of Captain Hutton's diagram, to which I have added the arc H A′ C′, and the dotted lines A′ T and C′ S.

Captain Hutton assumes the under surface of the bird at 8 feet, its weight at 16 lbs., the surface of the wings at (about) three times that of the body and tail, and the upward current of air necessary to support the bird against gravity, at 30 feet per second acting upon the whole bearing surface.

"Let A B" he says, "represent the axis of the body of the bird flying in the direction B A and at an angle A E H to the horizon. Let C D represent the wings making ∠ C E H with the horizon. Take the line H E to represent the velocity at which the bird is flying, or the number of feet it passes through the air in one second. From H draw the perpendicular H A, the line will represent the distance which the bird will rise (omitting for the present the force of gravity) by means of the angle at which he is flying to the horizon." Here Captain Hutton first assumes that the number of feet the bird travels in one second = H E and then that the bird will pass in the same time through the longer distance A E. The mistake leads him to the further error of adopting H E tan A E H as the measure of the vertical component of the

atmospheric resistance instead of H E sin A E H. If we take A′E=H E and draw the perpendicular A′T, then A′T represents the height the body would rise (irrespective of gravity) in one second. Now A′T=A E sin A E H =H E sin A E H.

Again, Captain Hutton has unaccountably adopted a totally different method to arrive at the vertical component of resistance in the case of the wings, and has resolved the force represented by H E into (1) H K non-effective (2) L E, resisting gravity, and (3) K L retarding the motion of the bird. He has thus arrived at the strange conclusion that at one angle of inclination (and for the body of the bird) the upward pressure is in proportion to the tangent of the angle, i.e., to the ratio of the sine to the cosine $\left(\frac{\sin \text{A E H}}{\cos \text{A E H}}\right)$ and that at another angle (for the wings) it is in proportion to the product of the sine and cosine of the angle of inclination (sin C E H. cos C E H). The error lies here. On his own assumption H E is the absolute velocity in one second, therefore the retarding force has been overcome in addition to the production of so much motion. The whole force exerted by the bird is, in fact, H E + R where R : H E :: K L : K E, ∴ it is not L E but K E (=H E sin C E H) which represents the vertical component of the force actually at work. Instead therefore of H A and L E as measures of the upward pressures on the body and wings respectively, we must take H E sin A E H and H E sin C E H.

Captain Hutton goes on to say "the total amount the bird will rise per second will be L E + H A feet." Introducing the corrections just made, this amounts to saying that the upward pressure on the whole area of the bird =H F (sin A E H + sin C E H). This is a grave error.

Let P be the total pressure which supports the bird;
p the average pressure on each square foot of sustaining surface;
M the area of the lower surface of the body and tail;
N the area of the under surface of the wings;

Then it is evident that P=M × H E sin A E H + N × H E sin C E H.

Now by the assumed data $p=\frac{P}{8}$ M=2 and N=6 therefore

$$\therefore p = \frac{\text{H E} \sin \text{A E H} + 3.\ \text{H E} \sin \text{C E H}}{4} \quad . \quad . \quad . \quad (1)$$

Also p = 2 lbs. per square foot, and is assumed to represent the pressure of an upward current of air having a velocity of 30 feet per second. From this we obtain

$$\text{H E} = \frac{120}{\sin \text{A E H} + 3.\ \sin \text{C E H}} \quad . \quad . \quad . \quad . \quad . \quad (2)$$

This equation gives, when ∠ A E H=0°, and C E H=15°,

$$\text{H E} = \frac{120}{3 \times .258819} = 155 \text{ (nearly)} \quad . \quad . \quad . \quad . \quad (3)$$

And for ∠ A E H=7°, and ∠ C E H=22°,

$$\text{H E} = \frac{120}{.121869 + 3 \times .374607} = 96 \text{ (and a little more)} \quad . \quad (4)$$

Captain Hutton closes this part of his calculations at this stage, and omits to consider that as the angle of flight is increased, the sustaining surface is reduced in the same proportion as the cosine of the ∠ of inclination to the horizon. In passing from the conditions of equation (3) to those of (4), this

cause is influential to the extent of about 4 per cent. Hence the bird will not preserve a horizontal flight, if the velocity falls below 100 feet per second, without increasing its angle of flight more than the assumed 7°. Another slight error occurs in Captain Hutton's calculations which is probably an oversight. Using his equation $H E = \frac{30}{\tan\ A E H + \sin\ C E H \ .\ \cos C E H}$ he makes H E = 115, when A E H = 0, and C E H = 15°. The true result is 120.

When proper data have been obtained, the solution of the problems connected with this "sailing flight" should, I think, be approached in an entirely different manner from that adopted by Captain Hutton. His deductions as to the resistance of the air to a projectile of the form of the albatros are of no value at all, and may, I think, be shown to be inconsistent with facts already ascertained. The principal portion of the resistance is that which is resolved into a sustaining, or upward bearing, force, and this is exerted against the obliquely exposed under surfaces of the bird. The formula for the resistance of a fluid to a plane, moving obliquely through it is—

$$R = \tfrac{1}{2}\ Q\ v^2\ \sin^3 I.\ A$$

where Q is the density of the fluid, v the velocity of the stream *plus* that of the plane if it is moving against it, I the $\angle$ of inclination to the stream, and A the area of the plane. The two latter coefficients will have to be determined from observations, which in the case of I it will be very difficult to make. If the part of R which is resolved into a force sustaining the bird against gravity be known, let this = C, then the *retarding* force of atmospheric resistance against the inclined surfaces of the body and wings,—

$$= \tfrac{1}{2}\ Q\ v^2\ \sin^3\ I.\ A - C$$

We must deduct this quantity from the whole retardation observed to find what would be the resistance to the front surfaces of the bird when both body and wings were horizontal. It is only by this process that we can obtain a quantity which is comparable with the atmospheric resistance to round shot.

ART. LX.—*On Sinking Funds.* By Captain F. W. HUTTON, F.G.S.

[Read before the Auckland Institute, September 7, 1868.]

THE subject of Sinking Funds is one of much importance to this and other countries, but I have not been able to find any book that treats of it, and I therefore think that an investigation of its principles may prove both useful and interesting.

By "Sinking Fund" is meant a sum of money put away annually in order to pay off a loan. There are two principal ways in which this money is applied: either it may be invested year by year until, with the interest accruing on it, it amounts to a sum sufficient to pay off the original loan; or else it may be used to take up yearly a portion of the loan until the whole has vanished. I propose to investigate both these methods, and then compare them together.

The second case, where the fund is applied yearly to buy up the loan, is very simple.

Let a equal the amount of the loan.
,, p the amount put by as Sinking Fund each year, and
,, T equal the number of years it will take to pay off the loan. Then

it is evident that as $\frac{1}{p}$ of the loan is brought up every year,

$$T=\frac{a}{p} \quad . \quad . \quad . \quad (1)$$

$$p=\frac{a}{T} \quad . \quad . \quad . \quad (2)$$

$$a=p\,T \quad . \quad . \quad . \quad (3)$$

With regard to the first case: let a and p be as before, but let t be the number of years it will take to pay off the loan by this method, and let v equal 1 + the interest on one pound at the rate at which the Sinking Fund is invested, so that if it is invested at 5 per cent. it will equal 1.05.

Now at the end of the

1^{st} year the fund will amount to $p\,v$

2^{nd} ,, ,, ,, $(p+p\,v)\,v = p\,v+p\,v^2$

3^{rd} ,, ,, ,, $(p\,v+p\,v^2+p)\,v = p\,v+p\,v^2+p\,v^3$

t^{th} ,, ,, ,, $p\,v+p\,v^2+p\,v^3+\&c. \ldots\ldots p\,v^t$

but at the end of the last or t^{th} year, the fund must equal *a*

$$\therefore \quad p\,v+p\,v^2+p\,v^3+\&c. \ldots\ldots p\,v^t=a$$

multiply by v and $\quad p\,v^2+p\,v^3+p\,v^4+\&c. \ldots\ldots p\,v^{t+1}=a\,v$

subtracting $\quad p\,v^{t+1}-p\,v \quad = \quad a\,v-a$

$$\therefore \quad a\,(v-1)=p\,v\,(v^t-1). \quad . \quad . \quad . \quad (4)$$

$$\therefore \quad a=\frac{p\,v\,(v^t-1)}{v-1} \quad . \quad . \quad . \quad . \quad (5)$$

$$p=\frac{a\,(v-1)}{v\,(v^t-1)} \quad . \quad . \quad . \quad . \quad (6)$$

When p is known the per centage required for forming a Sinking Fund equal to p can be found by multiplying p by 100 and dividing by *a*.

$$\text{From (4) we get } v^t-1=\frac{a\,(v-1)}{p\,v}$$

$$\therefore \quad v^t=\frac{a\,(v-1)+p\,v}{p\,v}$$

$$\therefore \quad t\log v=\log\left\{a\,(v-1)+p\,v\right\}-\log p\,v$$

$$\therefore \quad t=\frac{\log\left\{a\,(v-1)+p\,v\right\}\log p\,v}{\log v} \quad . \quad . \quad (7)$$

$$\text{From (4) we also get } p\,v^{t+1}-(a+p)\,v+a=o \quad . \quad (8)$$

From which v can be found by the following rule, known as Bernoulli's.

1. Find by trial two numbers nearly equal to t.
2. Substitute these assumed numbers for t and mark the error that arises from each with + if too great, and − if too small.
3. Multiply the difference of the assumed numbers by the least error, and divide the product by the difference of the errors when they have like signs, but by their sum when they have unlike.
4. Add the quotient to the assumed number belonging to the least error when that number is too little, or subtract if too great.

5. This operation may be repeated until t is found sufficiently near.

I will now take the total amount of interest that has to be paid on the loan until it is all taken up.

This on the first system will evidently be $a\ t\,(v'-1)$, where v' is $1+$ the interest that has to be paid on one pound of the loan for a year.

On the second system the interest payable at the end of the

1st	year would be		$(a-p)\ (v'-1)$
2nd	„	„	$(a-2p)\ (v'-1)$
3rd	„	„	$(a-3p)\ (v'-1)$
$(T-1)$	„	„	$(a-(T-1)\,p)\ (v'-1)$.

But the year before the whole loan was taken up only $\frac{1}{p}$th of it would be left, it is evident that $a-(T-1)\ p=p$

So that we have an equidifferent series of which $(a-p)\ (v'-1)$ is the first term, $p\ (v'-1)$ the last, and T 1 the number of terms. The sum of them therefore, or the whole interest to be paid on the loan

$$\frac{T-1}{2}\left\{(a-p)\ (v'-1)+p\ (v'-1)\right\}$$

$$=\frac{a\ (v'-1)}{2}(T-1)$$

Therefore

$$a\ (v'-1)\ t : \frac{a\ (v'-1)}{2}(T-1) :: \left\{\begin{matrix}\text{amount of interest}\\ \text{by first method}\end{matrix}\right\} : \left\{\begin{matrix}\text{amount of interest}\\ \text{by second method}\end{matrix}\right.$$

$$\text{Or}\quad 2t : T-1 :: \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad : \quad . \quad . \quad . \quad . \quad .$$

But besides the interest on the loan there has also to be paid for the Sinking Fund by the first method $p\ t$ pounds, and by the second method $p\ T$ pounds. So that

$$p\,t : p\,T :: \left\{\begin{matrix}\text{amount paid for Sinking}\\ \text{Fund by first method}\end{matrix}\right\} : \left\{\begin{matrix}\text{amount paid for Sinking}\\ \text{Fund by second method}\end{matrix}\right.$$

And combining the two we get

$$2\,t+p\,t : T-1+p\,T :: \left\{\begin{matrix}\text{whole amount paid}\\ \text{by first method}\end{matrix}\right\} : \left\{\begin{matrix}\text{whole amount paid}\\ \text{by second method}\end{matrix}\right.$$

$$\text{Or}\ (p+2)\,t : (p+1)\,T-1 :: \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad : \quad . \quad . \quad . \quad . \quad .$$

Now the limits of p are o and a, and as it gets small both T and t increase, but t will increase slower that T for it also depends upon the value of v which remains stationary. On the contrary as p gets large t will decrease more slowly than T for the same reason, and the position of equality will of course depend upon the values of v and a. If however we take $a>1000$; $p<\frac{a}{14}$, and $v=1.05$—which in practice will include all cases—it will be found that

$$(p+2)\ t<(p+1)\ T-1.$$

The actual amount that would have to be spent by either method can be easily found by substituting in the following formulæ the different values for a, p, v, and v'.

By the first method $\left\{ a\,(v'-1)+p \right\} \cdot \dfrac{\log \left\{ a\,(v-1)+p\,v \right\} - \log p\,v}{\log v.}$.

By the second method $\dfrac{a\,(v'-1)\,(a-p)}{2\,p} + a.$

From this comparison it follows that when money can be invested at 5 per cent., and the Sinking Fund is less than 7 per cent. of the loan, the first is the more economical method; and the smaller the Sinking Fund, and the higher the rate of interest, the greater will be the saving effected by investing the fund in other securities, than by using it to buy up annually part of the loan.

This however is only the mathematical or pecuniary view of the question; from the political point of view many reasons can be given why the second method should be preferred, and the difference pecuniarily is not sufficiently great to override them.

ART. LXI.—*List of Plants found in the Northern District of the Province of Auckland.* By J. BUCHANAN and T. KIRK.

[IN the course of the geological survey of the above district in 1865-6, an extensive collection of plants was made by Mr. Buchanan, and forwarded to Dr. Hooker, at Kew. They were, however, unfortunately, distributed by an assistant without being examined, so that a complete list was not obtained, and any few novelties escaped notice in the appendix to Vol. ii. of the "Handbook of the New Zealand Flora."

From the portion of the collection retained, and from notes made on the spot, Mr. Buchanan compiled the greater part of the following list, with the exception of the natural orders, Junceæ, Restiaceæ, Cyperaceæ, and Gramineæ, the lists of which are furnished altogether by Mr. Kirk. As Mr. Buchanan collected in the months of November and December, and Mr. Kirk went over most of the same ground in April, the latter observer was also able to add largely to the number of plants, the results, as combined in the following lists, should give a tolerably complete Flora of each locality indicated.

An account of the chief plants of interest obtained by Mr. Kirk is given in a paper published in the "Transactions" for last year (p. 140); along with which his contribution to the following tables was to have been printed, had not circumstances prevented it.

For the characteristic plants of the district, and a comparison of its botany with that of other parts of New Zealand, the reader is referred to Mr. Colenso's Essay, also in Vol. i. of the "Transactions."—ED.]

Introductory Remarks by J. BUCHANAN.

The above area may be divided into eight districts, viz.:—

1. Wangarei,
2. Bay of Islands,
3. Wangaroa,
4. Stephenson's Island,

the latter as showing the comparative botany of a portion of land detached from the Main Island.

5. Mount Camel,
6. North Cape.

Nos. 5 and 6 are isolated districts, the latter, in a great measure, cut off from the general Flora by a peninsula of sand-hills, nearly 70 miles in length.

7. Kaitaia,
8. Hokianga.

The general facies of the vegetation over the whole is alternately bush, and open scrubby or fern land; there being very little natural grass land, the largest area being that at the North Cape, and even there the prevailing species are not indigenous to New Zealand. The whole country has been, at no distant time, covered by bush, which, no doubt, has been partially cleared off by fires, as extensive denudation by this means is still in progress.

The most of the open land yields Kauri gum, which is obtained by digging for a few feet beneath the surface, thus proving the Kauri pine (*Dammara australis*) to have formerly been the prevailing species of tree. It might be safely inferred from this fact alone, that a soil capable of producing such heavy forest growth, should now yield heavy crops of other kinds; and so it would under conditions of sufficient moisture.

In addition to the known influence of trees, in drawing more frequent rains, evaporation is also checked, but dry soils, such as the Kauri gum land of Auckland, or the Manuka land of Otago, are always more easily burned in dry seasons; and as, with every additional area added to the open country, the whole will become more arid, it may in the end defy all improvement, even with the aid of agricultural science. In the meantime, it is probable that the prevailing idea that this open land is barren, may be an error; but the principal reason for this idea is its aridity; it is a question therefore of some importance whether further extensive denudations of bush may not render the country positively barren, except in valley bottoms.

As in other parts of New Zealand, the greatest extent of the open land in the northern district of Auckland, is found on the east coast. Much of it is covered by fern (*Pteris esculenta*), but more commonly the vegetation is mixed, including *Leptospermum scoparium*, *L. ericoides*, *Pomaderris elliptica*, *P. phylicifolia*, *Dracophyllum Urvilleanum*, *Coriaria ruscifolia*, *Leucopogon fasciculatum*, *Weinmannia sylvicola*, *Gleichenia circinata*, *Epacris pauciflora*, *Phormium tenax*, with smaller plants of the Orders Lycopodiaceæ, Cyperaceæ, Grasses and Ferns.

The bush is rich in fine species, many of which are found only in the northern half of the North Island, although a few may push stragglers further south; the following are prominent species:—*Dammara australis*, *Nesodaphne Tarairi*, *Vitex littoralis*, *Avicennia tomentosa*, *Metrosideros tomentosa*, *Tetranthera calicaris*, *Sapota costata*, *Ixerba brexioides*, *Quintinia serrata*, *Pittosporum umbellatum*, *P. Kirkii*, *P. Huttoniana*, *Phebalium nudum*, *Phylloclades trichomanoides*, *Colensoa physaloides*.

Such is the sameness of conditions of plant-growth over this northern part of New Zealand, that the vegetation may be classed under two Zones, *Littoral*, and *Interior*. No sufficient altitude existing to produce any change worthy of notice. On Maungataniwha (2700 feet), the greatest elevation in these districts, the bush covering the top, is not stunted in growth, which is the first thing noticed on ascending a mountain, if change is produced by altitude. Again on Taratara Hill, inland from Wangaroa Bay, where a portion of the summit is open land, the vegetation is identical with that of the lower levels.

As I have had an opportunity of comparing the vegetation at the extremes of latitude in New Zealand, I may state that many prominent species range over the whole islands; of such are, *Myrsine Urvilleanum*, *Aristotelia racemosa*, *Myoporum lætum*, and the more important species of the Natural Order

Coniferæ; such plants are found equally abundant and luxuriant in the north, as in the extreme south.

Others again find their northern limits before reaching the North Cape district, or dwindle in size from the locality of their maximum growth in the South Island. Of such are some of the Pittosporums, *Leptospermum ericoides*, and *L. scoparium*, *Fuchsia excorticata*, *Griselinia littoralis*, *Drimys axillaris*, and *D. Colorata*.

The birch forests (Fagus), which are so important in the South, are also absent from the North, a few stragglers only being found on the line of the main ranges.

In the district under notice, frequent instances may be found of that disposition to vary, so common among New Zealand species of plants, the cause of which by some has been ascribed to the whole Flora having arrived at such a delicate state of balance, that any small disturbance would produce a great change; but I think it more probable that causes of change have always been in operation while a Flora existed in the islands; and if the range of latitude, and thermal variations which must exist over such a range be considered, it will only require the transportation of plants from localities well suited to them, and *vice versa*, to produce some variation of form, as we see.

As might be expected, arid winds seem to exert a stronger influence, in producing plant variation, than even temperature. For instance, at the North Cape, and Cape Maria Van Diemen, species such as *Myoporum lætum*, *Coprosma acerosa*, and others, even under the dry warm winds of that latitude, may be seen dwarfed and stunted, flattened out on the ground, and hiding themselves, as it were, behind the sand-hills. The same may be seen at Mount Camel, where large patches of low copse forest of the Akerautangi (*Dodonæa viscosa*) cover the ground, whereas the same plant at Nelson, 7° of latitude further south, forms a handsome, though small tree. In these cases where the causes to variation are not so evident and direct as the action of arid winds, it would appear that the tendency of a plant to vary is increased with the distance from its centre of maximum growth.*

I am inclined to the opinion that variation in some species shows its derivative track by the young plants reverting to some older type form. As an instance of this, *Weinmannia Sylvicola* is often seen, in the young state, dotted over the open Kauri gum land, having only imparipinnate leaves, while the older tree assumes a ternate form in the upper branches; and in full adult trees, the foliage becomes unifoliolate in the upper branches, and ternate in the lower—thus, I infer, showing the typical foliage of two species now extinct. It is even probable that the above species has passed through one form that still exists in the South, *Weinmannia racemosa*, which also shows the extinct form of ternate leaves, but only in the young plant and lower branches.

The limits of this paper will not allow further illustrations of this curious point, although there might be many added with facility. Local collectors will always be liable, in New Zealand, which possesses such a varying Flora, to be deceived with supposed new discoveries, and may be frequently puzzled, from the descriptions in Hooker's "Handbook" having been frequently taken from specimens found only in one locality. Thus, no southern collector has

*As illustrative of the influence of humidity or aridity on plant variation, the Kowhai (*Sophora tetraptera*) may be taken as an example. Near Dunedin it may be said to have acquired its maximum of growth, under the conditions of excess of cold humid winds. On the west coast of the South Island, again, under conditions of warm humid winds, it is a delicate drooping branched shrub-tree, while on the seaward grass hills of Marlborough, under the conditions of an arid cold wind, the same plant has become dwarfed to a few inches high, covering patches of ground, and rigid enough to be walked on; temperature here shows the least influence, as otherwise the West Coast variety would have been the largest.

probably seen the young plants of *Panax Colensoi*, or *Schefflera digitata*, with lobulate leaves, yet such are found in the North. Again, he might be puzzled to find *Pittosporum tenuifolium* with fasicles of flowers in the upper branches, and alternate in the lower. Some of the plants of this genus are remarkably varied in different localities, and to found species on distinctions of flowers being umbellate or alternate, fasicled or alternate, is simply to produce confusion, for as far as the present extent of variation has gone, there is always a common facies in all the varieties of a species, which never can be mistaken.

So inconstant, and limited in distribution are some varieties, that it is necessary to know the New Zealand Flora in every locality, to be able to describe a species, and even opinions on the value of timber, etc., have only a local value from the same cause. Hence the necessity of local observations by many persons, and a combination of the results of their labours, as by such means only will future botanists be able to make out the true cause and laws of variation in plants.

RANUNCULACEÆ.
Clematis indivisa, 1 2 3 6 7 8
„ Colensoi, 1 2 6 7
„ parviflora, 1
Ranunculus plebeius, 1 2 3 5 6 7 8
„ multiscapus, 1 2
„ rivularis, 1 2 3 7
CRUCIFERÆ.
Nasturtium palustre, 2 6
Barbarea vulgaris, 1 2 6
Cardamine hirsuta, 1 2
Lepidium oleraceum, 1 2
VIOLAREÆ.
Melicytus ramiflorus, 1 2 3 4 5 6 7 8
„ macrophyllus, 2 5 6
„ lanceolatus, 1
Hymenanthera crassifolia, 5 6
PITTOSPOREÆ.
Pittosporum tenuifolium, 1 2 3 6 7 8
Colensoi, 1 2 3 8
reflexum, 1
crassifolium, 1 2 3
umbellatum, 1 2 3 8
eugenioides, 1 2 8
cornifolium, 1 2 3 8
Kirkii, 1
Huttoniana, 1
CARYOPHYLLEÆ.
Colobanthus Billardieri, 5
ELATINEÆ.
Elatine americana, 2
HYPERICINEÆ.
Hypericum gramineum, 1 2
MALVACEÆ.
Plagianthus divaricatus, 1 2 3 6
„ betulinus, 2 8
Hoheria var. a, vulgaris, 1 2 5 6 7 8
var. b, lanceolata, 1
var. c, angustifolia, 1 2 3 6 7
var. d, cratægifolia, 5 7 8
Hibiscus Trionum, 1 6 7
„ Taylorii, 6
TILIACEÆ.
Entelea arborescens, 1 2 3 4 6 7 8
Aristotelia racemosa, 1 2 3 6 7 8
Elæocarpus dentatus, 1 2 3 6 7 8
LINEÆ.
Linum monogynum, 1 2 3 6 8
GERANIACEÆ.
Geranium carolinianum, 1 2 4 5 6 7 8
„ microphyllum, 1 2 3 6 8
Pelargonium clandestinum, 1 6
Oxalis corniculata, 1 2 3 5 6 7 8
„ magellanica, 2 7
RUTACEÆ.
Phebalium nudum, 1 2 3 7 8
Melicope ternata, 1 2 3 6 7
„ Mantellii, 1 2 7
„ simplex, 1 2 3
MELIACEÆ.
Dysoxylum spectabile, 1 2 3 5 7 8
RHAMNEÆ.
Pomaderris elliptica, 2 3 5 6 7
„ Edgerleyi, 1 6
„ phylicifolia, 1 2 3 4 5 6 7 8
SAPINDACEÆ.
Dodonæa viscosa, 1 2 3 6 7 8
Alectryon excelsum, 1 2 3 6 7 8
ANACARDIACEÆ.
Corynocarpus lævigata, 1 2 3 4 5 6 7 8
CORIAREÆ.
Coriaria ruscifolia, 1 2 3 4 5 6 7 8

1. Wangarei. 2. Bay of Islands. 3. Wangaroa. 4. Stephenson's Island. 5. Mount Camel. 6. North Cape. 7. Kaitaia. 8. Hokianga.

LEGUMINOSEÆ.
Carmichælia australis, 1 2 3 5 6 7 8
Sophora tetraptera, var. a, 1 2 3 6 7 8
ROSACEÆ.
Rubus australis, 3 vars., 1 2 3 6 7 8
Acæna Sanguisorbæ, 1 2 3 4 5 6 7 8
SAXIFRAGEÆ.
Quintinia serrata, 1 7
Carpodetus serratus, 1 2 3 6 7 8
Ackama rosæfolia, 1 2 7 8
Weinmannia sylvicola, 1 2 3 5 6 7 8
DROSERACEÆ.
Drosera pygmæa, 2 8
„ spathulata, 2
„ binata, 1 2 3 6 7 8
„ auriculata, 1 2 7
HALORAGEÆ.
Haloragis alata, 1 2 5 6
„ depressa, 1 2 3 6 7
„ micrantha, 1 2 3 6 7
„ tetragyna, 3 5 7
„ diffusa, 1 6
Myriophyllum variæfolium, 1 5
Gunnera monoica, 2 6
Callitriche, 2
MYRTACEÆ.
Leptospermum scoparium, 1 2 3 4 5 6 7 8
„ ericoides, 1 2 3 5 6 7 8
Metrosideros florida, 1 2 3 7 8
„ albiflora, 1 2 3
„ hypericifolia, 1 2 3 5 7 8
„ robusta, 1 2 3 6 7 8
„ tomentosa, 1 2 3 4 5 6 7 8
„ scandens, 1 2 3
Myrtus bullata, 1 2 3 5 6 7 8
„ Ralphii, 1 2
„ pedunculata, 1 2 3 8
Eugenia Maire, 1 2 3 6 7 8
ONAGRARIEÆ.
Fuchsia excorticata, 1 2 3 6 7 8
Epilobium nummularifolium, 1 2 3 6 8
„ tetragonum, 1 6 7
„ glabellum, 1 3 6 7 8
„ junceum, 1 2 3 6
„ Billardierianum, 6 8
„ pallidiflorum, 1 2 6 7
PASSIFLOREÆ.
Passiflora tetrandra, 1 2 7 8
FICOIDEÆ.
Mesembryanthemum australe, 1 2 3 4 5 6 7 8
Tetragonia expansa, 1 5 6 8
UMBELLIFERÆ.
Hydrocotyle elongata, 1 2 3 8
„ Asiatica, 1 2 3 6
Crantzia maritima, 6
Apium australe, 1 2 3 4 5 6 8
„ filiforme, 2
Angelica rosæfolia, 1
Daucus brachiatus, 5 6
ARALIACEÆ.
Panax simplex, 1 2 3 6 7 8
Edgerleyi, 1 2 3 6 8
crassifolium, 1 2 3 6 7 8
Lessoni, 1 2 3 5 6 7 8
arboreum, 1 2 3 5 6 7 8
anomalum, 3
Schefflera digitata, 1 2 3 5 6 7 8
CORNEÆ.
Griselinia lucida, 1 2 3 8
„ littoralis, 1 2 3 7 8
Corokia buddleoides, 1 2 7
„ cotoneaster, 1 6
LORANTHACEÆ.
Loranthus tetrapetalous, 1 2 3 8
„ micranthus, 1 2 3 8
Tupeia antarctica, 1 2 3 6 7
CAPRIFOLIACEÆ.
Alseuosmia macrophylla, 1 2 3 8
„ Banksii, 1 2 3 7 8
„ linariifolia, 1 2 3
RUBIACEÆ.
Coprosma lucida, 1 2 3 5 6 8
„ grandifolia, 1 2 3 5 6 7 8
„ Baueriana, 1 2 4 5
„ petiolata, 6 7 8
„ Cunninghamii, 2
„ robusta, 1 2 3 4 5 6 7 8
„ spathulata, 1 2 3 7 8
„ rotundifolia, 1 2
„ tenuicaulis, 1 2 3 8
„ divaricata, 1 2 5 6 7 8
„ parviflora, 1 7 8
„ acerosa, 1 2 3 6 7 8
„ linariifolia, 1 2 3 6 7 8
Nertera dichondræfolia, 1 2 8
Galium tenuicaule, 1
COMPOSITÆ.
Olearia furfuracea, 1 2 3 8
„ Cunninghami, 1 2 3 6 7 8
„ albida, 1 2 3 6 8
„ virgata, 1 2 5 6 7
„ Solandri, 1 2 3 6 8
Celmisia (Monroi ?), 1

1. Wangarei. 2. Bay of Islands. 3. Wangaroa. 4. Stephenson's Island. 5. Mount Camel. 6. North Cape. 7. Kaitaia. 8. Hokianga.

Lagenophora Forsteri, 1 2 3 6 7 8
,, lanata, 1 2
Bidens pilosa, 1 5 6
Cotula coronopifolia, 1 2 3 7
,, australis, 6
,, minuta, 6
Cassinia retorta, 1 2 6 8
,, leptophylla, 1 2 3 4 6 8
Ozothamnus glomeratus, 1
,, lanceolatus, 8
Gnaphalium luteo-album, 1 6
,, Keriense, 1 6
,, involucratum, 1 2 6
,, collinum, 1 2 6
Senecio lautus, 1 2 3 6 8
,, glastifolius, 1 2 3 5 6 7 8
Brachyglottis repanda, 1 2 3 5 6 7 8
Picris hieracioides, 1 2 6
Sonchus oleraceus, 1 2 6 7 8

CAMPANULACEÆ.

Wahlenbergia gracilis, 1 2 4 5 6 7 8
Colensoa physaloides 3 6 7 8
Lobelia anceps, 1 2 3 4 5 6 7 8
Selliera radicans, 1 2 6 7 8

ERICEÆ.

Gaultheria antipoda, 1 2 3 6
,, rupestris, 1 2 3 6 7 8
Cyathodes acerosa, 1 2 3 5 6
Leucopogon fasciculatus, 1 2 3 5 6 7 8
,, Frazeri, 1 2 4 6 8
Epacris purpurascens, 1 2 5 6
,, pauciflora, 1 2 3 5 6 7 8
Dracophyllum latifolium, 1 2 3 6 7 8
,, squarrosum, 2 3
,, Urvilleanum, 1 2 5 6 7 8

MYRSINEÆ.

Myrsine salicina, 1 2 3 6 8
,, Urvillei, 1 2 3 5 6 7 8

PRIMULACEÆ.

Samolus littoralis, 1 2 3 6 7 8

SAPOTEÆ.

Sapota costata, 1 2 5 6

JASMINEÆ.

Olea Cunninghami, 1 3 7 8
,, lanceolata, 1 3 6 7
,, montana, 1 2 3

APOCYNEÆ.

Parsonsia albiflora, 1 2 3 6 7 8

LOGANIACEÆ.

Geniostoma ligustrifolium, 1 2 3 4 5 6 7 8

CONVOLVULACEÆ.

Convolvulus sepium, 1 2 3 6 7 8
Convolvulus Tuguriorum, 1 2 6 8
,, Soldanella, 1 2 6 7 8
,, erubescens, 6
,, marginata, 1 2
Ipomœa tuberculata, 2 5 6 7
Dichondra repens, 1

SOLANEÆ.

Solanum aviculare, 1 2 3 6 7 8
,, nigrum, 1 2 6 7 8

SCROPHULARINEÆ.

Gratiola sexdentata, 2
,, nana, 1 2 7
Glossostigma elatinoides, 2
Veronica speciosa, 8
,, macroura, 1 6
,, salicifolia, 1 2 3 4 6 7 8
,, parviflora, 1 2 5 6 7 8
,, ligustrifolia, 1 2
,, diosmæfolia, 2 6 7 8
,, elongata, 2

GESNERIACEÆ.

Rhabdothamnus Solandri, 1 2 3 6 7 8

VERBENACEÆ.

Vitex littoralis, 1 2 3 5 6 7 8
Teucridium parvifolium, 3
Avicennia officinalis, 1 2 3 6 8
Myoporum lætum, 1 2 3 5 6 7 8

LABIATÆ.

Mentha Cunninghami, 1 2

PLANTAGINEÆ.

Plantago Raoulii, 5 6

NYCTAGINEÆ.

Pisonia Brunoniana, 1 2

CHENOPODIACEÆ.

Chenopodium ambiguum, 1 6 7
,, ambrosioides, 1 2 6
,, carinatum, 1 2 6
Salicornia indica, 1 2 3 6 7 8

AMARANTHACEÆ.

Alternanthera sessilis, 1 2 5 6 7

PARONYCHIEÆ.

Scleranthus biflorus, 1 4 6

POLYGONEÆ.

Polygonum decipiens, 1 2 6
,, aviculare, 1 2 6 7
Muhlenbeckia adpressa, 1 2 6 7
,, complexa, 1 2 3 5 6 7 8
Rumex flexuosus, 1 2 6 7

LAURINEÆ.

Tetranthera calicaris, 1 2 3 5 6 7 8
Nesodaphne Tarairi, 1 2 3 5 6 7 8
,, Tawa, 1 2 3 6 7 8
,, var. Tawa-rau-nui, 1 2

Cassytha paniculata, 6
MONIMIACEÆ.
Atherosperma Novæ Zelandiæ, 1 2 3 7 8
Hedycarya dentata, 1 2 3 5 6 7 8
PROTEACEÆ.
Knightia excelsa, 1 2 3 5 6 7 8
Persoonia Toro, 1 2 3 7 8
THYMELEÆ.
Pimelea virgata, 1 2 3 6 7 8
„ arenaria, 1 2 3 4 5 6 7 8
„ prostrata, 1 2 3 5 6 7 8
SANTALACEÆ.
Santalum Cunninghami, 1 2 3 7 8
EUPHORBIACEÆ.
Euphorbia glauca, 1 2 3 6 7 8
URTICEÆ.
Epicarpurus microphyllus, 1 2
Elatostemma rugosum, 1 2 3 7 8
CHLORANTHACEÆ.
Ascarina lucida, 1 2 3 7 8
PIPERACEÆ.
Peperomia Urvilleana, 1 2 6 8
Piper excelsum, 1 2 3 5 6 7 8
CONIFERÆ.
Dammara australis, 1 2 3 6 7 8
Libocedrus Doniana, 1 2 3 8
Podocarpus ferruginea, 1 2 3 6 7 8
„ Totara, 1 2 3 6 7 8
„ spicata, 1 2 3 6 7 8
„ dacrydioides, 1 2 3 6 7 8
Dacrydium cupressinum, 1 2 3 6 7 8
„ Colensoi, 3
Phyllocladus trichomanoides, 1 2 3 6 8
ORCHIDEÆ.
Earina mucronata, 1 2 3 8
„ autumnalis, 1 2 3 8
Dendrobium Cunninghami, 1 2 3
Bolbophyllum pygmæum, 1 8
Corysanthes triloba, 1 2
Microtis porrifolia, 1 2 3 7 8
Pterostylis Banksii, 1 2 3 7
Prasophyllum pumilum, 2 6 7
IRIDEÆ.
Libertia ixioides, 1 2
„ grandiflora, 1
PANDANEÆ.
Freycinetia Banksii, 1 2 3 8
TYPHACEÆ.
Typha angustifolia, 1 2 3 4 5 6 7 8
Sparganium simplex, 1
NAIADEÆ.
Lemna minor, 6
Triglochin triandrum, 1 2 6
Zostera marina, 1 3 6
Potamogeton heterophyllus, 2
LILIACEÆ.
Rhipogonum scandens, 1 2 3 6 7 8
Cordyline australis, 1 2 3 5 6 7 8
„ Banksii, 1 2 3 5 6 7 8
„ Pumilio, 1 2 3 5 6 7 8
Dianella intermedia, 1 2 3 6 7 8
Astelia Cunninghami, 1 2 3 4 5 6 7 8
„ Banksii, 1 2 5 6 7 8
„ Solandri, 1 2 4 5 6 7 8
„ grandis, 6
Arthropodium cirrhatum, 1 2 3 4 5 6 7 8
Phormium tenax, 1 2 3 4 5 6 7 8
„ Colensoi, 1 2 6 7
PALMEÆ.
Areca sapida, 1 2 3 6 7 8
JUNCEÆ.
Juncus communis, 1 6
„ planifolius, 1 2 6
„ australis, 2
„ maritimus, 2 6 8
„ effusus, 2
„ bufonius, 1 6 8
„ vaginatus, 6
Luzula campestris, 1 2 7 8
„ Oldfieldii, 1 2 7 8
„ pumila, 1 2 7 8
RESTIACEÆ.
Leptocarpus simplex, 1 2 6 7
CYPERACEÆ.
Cyperus ustulatus, 1 2 6 8
Schœnus, axillaris, 1 6
„ Tendo, 1 2 5 6
„ tenax, 1 2 5 6
Scirpus maritimus, 1 2 4 5 6 7 8
„ lacustris, 2
„ triqueter, 8
Eleocharis sphacelata, 2 6 7 8
„ var. gracillima, 1
„ platylepis, 2 6
Isolepis prolifer, 1 2 6
„ riparia, 2 6
„ nodosa, 6
Desmoschœnus spiralis, 1 2 3 4 6 7 8
Cladium glomeratum, 1 2 6
„ teretifolium, 1 2 6
„ articulatum, 1 2 6
„ junceum, 5 6 7
„ Sinclairi, 6
Gahnia setifolia, 1 7 8

1. Wangarei.	3. Wangaroa.	5. Mount Camel.	7. Kaitaia.
2. Bay of Islands.	4. Stephenson's Island.	6. North Cape.	8. Hokianga.

Gahnia lacera, 1 6
„ xanthocarpa, 1 3
„ arenaria, 1 2 6
Lepidosperma tetragona, 1 5 6 8
„ concava, 1 2 6
Uncinia australis, 1 8
„ Banksii, 1
Carex ternaria, 1 2 8
„ virgata, 1 2 3 7 8
„ pumila, 6 8
„ breviculmis, 1 6
„ dissita, 1 6
„ Lambertiana, 1 2
„ vacillans, 1 6

GRAMINEÆ.

Microlæna stipoides, 2
„ avenacea, 1
Spinifex hirsutus, 1 2 4 6 7 8
Paspalum scrobiculatum, 1 2 6
„ distichum, 6
Panicum imbecille, 1 2 6 7
Isachne australis, 1 2
Echinopogon ovatus, 2 4 7 8
Dichelachne stipoides, 4 5 6
Sporobolus elongatus, 1 2 6
Agrostis æmula, 6 7 8
„ Billardieri, 6
„ quadriseta, 2 6
Arundo conspicua, 1 2 3 4 5 6 7 8
Danthonia Cunninghami, 2
„ semi-annularis, 1 2 3 4 5 6 7 8
Poa breviglumis, 5
„ anceps, 1 5 6 7
„ foliosa, 4 5
Festuca scoparia, 5 6 8
„ littoralis, 1 2 7 8
Triticum multiflorum, 2

FILICES.

Gleichenia circinata, 1 2 3 6 7
„ flabellata, 1 2 6 7
Cyathea dealbata, 1 2 3 5 6 7 8
„ medullaris, 1 2 3 5 6 7 8
„ Cunninghami, 2
Dicksonia squarrosa, 2 7
„ lanata, 1 2 3 7 8
Hymenophyllum tunbridgense, 1 2 3 7 8
minimum, 3
rarum, 1 2 8
dilatatum, 1 2 3 6 7 8
crispatum, 1 2 3 8
polyanthos, 1 2 3 6 7 8
Hymenophyllum demissum, 1 2 3 6 7 8
„ scabrum, 1 2 3 8
Trichomanes reniforme, 1 2 3
„ strictum, 8
„ elongatum, 1 2 3 7
„ humile, 1 2
Loxsoma Cunninghami, 1 2
Lindsæa linearis, 1 2 3 6 7
„ trichomanoides, 1 2 8
Adiantum hispidulum, 1 2 5 6 7 8
„ Cunninghami, 1 2 6 8
„ fulvum, 1 2 6 7
„ æthiopicum, 1 2
„ formosum, 1
Hypolepis tenuifolia, 1 2 3 6 7 8
„ Millefolium, 1
„ distans, 1 3
Pellæa falcata, 2 3
„ rotundifolia, 1 2 3 6 7 8
Cheilanthes tenuifolia, 1 2 6 7
Pteris esculenta, 1 2 3 4 5 6 7 8
„ tremula, 1 2 3 5 6 7 8
„ scaberula, 1 2 6
„ incisa, 1 2 3 6 7 8
„ macilenta, 1 2 3 5 6 7 8
„ Endlicheriana, 1 4 5
Lomaria filiformis, 1 2 3 4 5 6 7 8
„ procera, 1 2 3 4 5 6 7 8
„ fluviatilis, 1 2 3 6 7 8
„ membranacea, 1 2
„ pumila, 1
„ lanceolata, 1 2 6 7
„ discolor, 1 2 3 6 7 8
„ Banksii, 6
„ Fraseri, 1 2 6 7 8
Doodia media, 1 2 4 5 6 7 8
„ caudata, 1 2 6 7 8
Asplenium obtusatum, 6
lucidum, 1 2 3 5 6 7 8
falcatum, 1 2 5 6 7
Hookerianum, 1 7
bulbiferum, 1 2 3 7 8
flaccidum, 1 3 5 7 8
australe, 1
Aspidium Richardi, 1 5 6 7 8
Nephrodium velutinum, 1 2 7
„ decompositum, 1 2 7
„ hispidum, 1 2 5 7 8
Polypodium australe, 1 3
„ Grammitidis, 1 2 7 8
„ tenellum, 1 7
„ rugulosum, 2
„ pennigerum, 1 2 5 6 7 8

1. Wangarei. 2. Bay of Islands. 3. Wangaroa. 4. Stephenson's Island. 5. Mount Camel. 6. North Cape. 7. Kaitaia. 8. Hokianga.

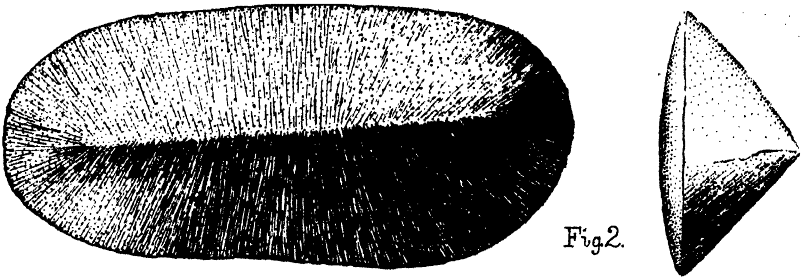


Fig.2.

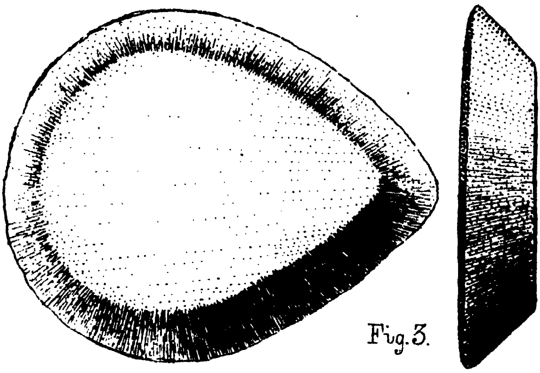


Fig.3.

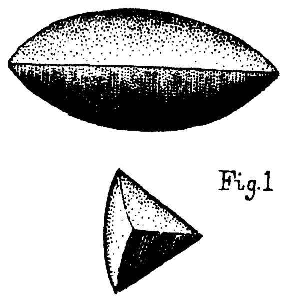


Fig.1

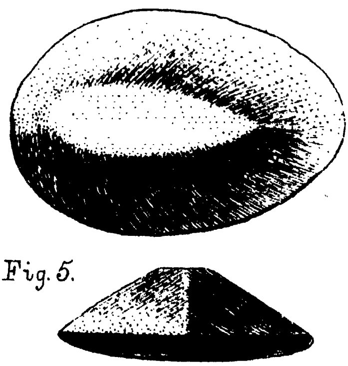


Fig. 5.

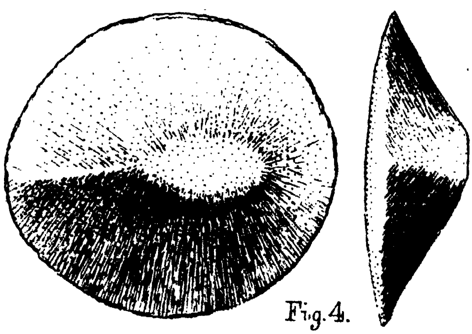


Fig.4.

WIND WORN STONES

Evans Bay Wellington

To illustrate Paper by W. T. L. Travers.

J. Buchanan del. & lith.

Printed at the Gen. Govt. Lith. Press by J. Barker

Polypodium rupestre, 1 2 5 6 7 8
„ Cunninghami, 1 2 3 5 7
„ pustulatum, 1 2 5 7 8
„ Billardieri, 1 2 3 4 5 6 7 8
Todea africana, 3 6
Leptopteris hymenophylloides, 1 2 3 5 8
Lygodium articulatum, 1 2 3 6 7 8
Schizæa dichotoma, 1 2 3 7 8
„ bifida, 1 7
Marattia salicina, 1 2
Ophioglossum vulgatum, 1
Botrychium cicutarium, 1 2 6

LYCOPODIACEÆ.

Lycopodium Billardieri, 1 2 3 7
„ densum, 2 5 6
„ laterale, 2 5 6
„ cernuum, 2 5
„ volubile, 1 2 3 5 6 7 8
Tmesipteris Forsteri, 1 2 6

1. Wangarei. 2. Bay of Islands. 3. Wangaroa. 4. Stephenson's Island. 5. Mount Camel. 6. North Cape. 7. Kaitaia. 8. Hokianga.

ART. LXII.—*On the Sand-worn Stones of Evans' Bay.* By W. T. L. TRAVERS, F.L.S.

(With Illustrations.)

[*Read before the Wellington Philosophical Society, February* 9, 1869.]

THE first specimen of these curious stones brought under my notice was given to me by young Mr. Hackworth, the son of the Acting Collector of Customs here, who informed me that he had found it near an old Maori kitchen-mound, in Lyall's Bay. This specimen (Fig. 1), is an inch and a half in length, pointed at both ends, and presenting three equal triangular facets. Both extremities of the stone have a slight twist in opposite directions, such as would, if it were used as an arrow-head, insure its more direct flight, in the same manner as the twist given to a bullet by the rifling of a gun. The facets, moreover, are perfectly smooth and slightly concave, and the edges quite sharp. A cross section anywhere would give an equilateral triangle, the greatest length of side, through the middle of the stone, being rather over half an inch. Looking to the extreme regularity of the shape of this stone, it is difficult, even with our present knowledge of the manner in which it was formed, to realize the fact that it is not an artificial production. When I first obtained it, I showed it to Dr. Hector and Mr. Mantell, and although we all came to the conclusion, at that time, that it was an artificial production, we were unable to assign any particular use to it. The most plausible suggestion was that it had been used to cut and polish the grooves in the "Hei Tiki" or jade ornaments worn by natives of rank. However, on applying to several Maoris, they said that they had never seen any stone like it, and that the grooves in the "Hei Tiki" were not cut in the manner suggested.

A short time after I received the stone I again saw young Mr. Hackworth, who described to me where he had found it, and promised to show me the exact spot, at the same time informing me that "there were plenty more there." This was somewhat puzzling, and soon afterwards I went to the locality indicated, in company with Dr. Hector and Mr. Mantell, who were both anxious to solve the apparent mystery, and we then found that this stone had been reduced to its present form by an action, and under circumstances which I will now describe to you, and at the same time we collected the series of illustrative specimens now on the table.

You all know the peninsula occupied by Mr. Crawford as a sheep run, which lies at the eastern side of Evans' and Lyall's Bays, and you also all know that the side of that peninsula adjoining those bays presents a pretty

regular hill face running north-west and south-east. The hills on the western side of both bays also present an equally regular slope running in the same direction. The distance between these two ridges is about half a mile, and the space intervening between the waters at the heads of Lyall's and Evans' Bays is occupied by a boulder bank and sand-dunes, about a mile or a mile and a quarter in width. The boulder bank lies in the middle of this space, and forms a ridge sloping from a summit towards both bays—the summit being slightly higher than the general level of the sand-dunes on either side of it. Between the boulder bank and the water line in each of the bays, lie these sand-dunes, composed of ordinary siliceous sea sand, here and there clothed with the vegetation usual to such habitats. The stones composing the boulder bank are chiefly sandstones, varying much in size and hardness, and in some instances intersected with little veins of quartz.

Now you are aware that the prevalent winds here are north-west and south-east, and blowing as they frequently do with considerable force through the opening between Evans' and Lyall's Bays, they are constantly carrying the sand of the dunes from one side of the boulder bank to the other. The motion of drift-sand is by a succession of jumps along the surface of the ground, and, strange as it may seem, it is the cutting action of the sand in its passage over the boulder bank which produces these stones. This is evident from an examination of the series of specimens before you, and becomes the more so when they are seen in the locality indicated. The action of drift-sand in cutting rock has long been observed, and, indeed, in the Museum you have many specimens illustrative of this action, but in no instance that I am aware of, has it been noticed as producing results of so remarkable a character, as those which I have so imperfectly brought before you.

The cutting action of drift sand has received much attention from geologists and engineers engaged in examining the line of the great Pacific railway, and it would be interesting to ascertain whether anything of the same kind had been observed by them.

PART II.

LECTURES.

On the NATURE OF ART. By JAMES EDWARD FITZGERALD.

[*Lecture delivered at the Colonial Museum, Wellington, August* 18, 1868.]

IT was once said that "Man made the town, but God made the country;" and I do not know that any expression more immediately or strikingly suggests the two great branches into which all human learning may be divided;—the two great divisions, in one or other of which must be placed all the objects which are presented for our curiosity or our study, in such a Museum as that in which I address you this evening.

The phenomena of nature, and the phenomena of man—the study of nature and the study of man—these two embrace the whole range of human enquiry.

It is no new discovery, although we seem to realize it more distinctly with every fresh step in scientific knowledge, that all the operations which are going on in the universe around us, all the subtle and manifold changes, which transform the external appearance of our planetary home, from epoch to epoch, year to year, season to season, and hour to hour, are conducted, not by the chapter of accidents, not by arbitrary will, but by fixed and irrevocable law.

In our present provisional and partial insight into nature, we call by technical names, and arrange and classify under technical systems, the unity of which, or the connection between which, are at present but very dimly perceived, those hidden relations which subsist between the particles of matter, and which produce the various phenomena which become the subject of our observation and study. That strange quality by which the planets revolve in their orbits, and the mountains remain fixed in their places undisturbed by the gyrations of the world in space, we call the law of gravity. We speak of the laws of chemistry and electricity, of light, and heat, and sound, of statics and dynamics, and of the rest and motion of fluids, and so on; and, with a far less definite sense of what we mean, we talk of the powers of animal and vegetable life; and perhaps the day may come, when we shall be able to recognise in all these various laws, the evidences of one all-comprehensive principle, impressed upon and inherent in all created matter, of which the laws at present within the scope of our philosophy are but partial and subordinate manifestations. However this may be, it will be admitted by all, that the tendency of scientific knowledge has been to present nature to us as under the influence of fixed law, as opposed to arbitrary will.

In the earlier ages of the world, when the intelligence of man had not penetrated beyond a superficial observation of the external appearance of things, he was wont to ascribe to the powers of nature, a personality similar to that which he recognised in himself. He loved to symbolise its localities and operations under the forms of imaginary beings, invested with such human characters and attributes as were suggested by the emotions and feelings which those localities and operations naturally awoke in his mind. Thus the streams and the groves, the winds and the ocean, the volcano and the whirlpool, were clothed in the language of the poet, and in popular belief, with the forms and characters of semi-human beings—fawns and satyrs, nymphs and dryads, Æolus with his cavern-bound winds, Neptune and his Tritons, Vulcan and his Cyclops; until every power of nature was endowed in popular superstition

with a personal and individual will, influenced by motives and subject to caprices similar to those of humanity, and operating sometimes for the benefit, and sometimes for the destruction of man.

It has not been until comparatively modern times, and even now, I fear, but over a small part of the human family, that scientific knowledge has triumphed over popular credulity; and that the realm of nature is presented to us in every part, as subject to immutable *law*, from which the idea of choice or will, of object or design, residing in matter itself or in the powers of nature, is absolutely excluded.

When, however, we pass from the phenomena of nature, to those connected with man, a new scene opens to our view. We stand face to face with free will; with a new creative power at work in the midst of the vast and complex machinery of nature. If you take two seeds from the same plant, apparently, so far as you can judge, similar in all respects, and plant them in the same soil, and in the same climate, there shall grow from them two trees widely differing from each other, in size, and strength, and character. Yet we do not suppose for a moment that any act of choice or will on the part of the tree has modified its form or its growth; but rather that the unknown incidents of nourishment and of atmosphere, of sunlight and of moisture, have dictated the development of every leaf and every fibre. But if you take two human beings, apparently similar in the cradle, subject them to the same education and the same influences, and observe them at successive periods of life, you are compelled to admit, that the result in each has not been arrived at solely by the operation of natural and mechanical laws, but by those laws modified, controlled, interfered with, by the operation of an independent force residing in the man himself,—by his power to choose or to refuse—by his free will.

At what exact point this free will first enters into the scale of nature, is perhaps the most insoluble of all the mysteries by which we are surrounded. Does it appear first with locomotion? Is the cow absolutely free to turn to the right hand or to the left, to crop the wholesome, and reject the poisonous herbage as she pleases? Or are all animals like plants, only more delicate and complicated parts in the one vast mechanism of nature? Or if we admit a certain degree of free will to the higher animals, shall we apply the same law to the oyster and the polypus? Or what shall we say of that large portion of animated nature, which lies in the border land between the animal and vegetable kingdoms? In truth it would appear as if not only the will, but most, if not all, the mental powers of man had their latent germs in the lower animals; and that these germs are more perfectly developed as we rise in the scale of creation. Thus we can trace in animals the emotions of courage and fear, memory and hope, love and hatred, gratitude and revenge, joy and sorrow, and a distinct though imperfect power of reason, connecting cause with effect and governing the actions accordingly. Of the creative power of imagination I am not aware that any trace has been discovered except in man.

To whatever extent, then, if to any, we may consider animals as governed by a personal will under the influence of moral emotions, superimposed upon mechanical law, it is certain that the evidence of such an independent will in man is infinitely greater than in any lower order of beings; and that, so far as we know, he stands alone amidst creation as possessing a creative power of imagination. And there is no reason, because impenetrable mist obscures the boundary line between matter subjected to mechanical law alone, and matter subjected, not only to such law, but to the operation of external and independent will, that we should therefore ignore the broad and unmistakable difference between the two classes of facts which present themselves at the opposite ends of the scale; between, on the one hand, such facts as are presented to us by chemical experiments, the result of which we can confidently

predict, and on the other, by the phenomena of human action and caprice, which elude all possibility of scientific mensuration.

I know, indeed,—and I notice it, not because it will enter into consideration this evening, but because it would be disingenuous if I were to pretend to be ignorant of the fact;—I know it has been argued, that man himself, not only in his lower and material organisation, but even in the more subtle and impalpable action of his reason, his imagination, and his will, is equally the unconscious subject of the same immutable law which he recognises in external nature; that he is no more than a passive and predestinated instrument, no more than one inert link, in the mechanical chain of cause and effect, which unites the past to the future in the sequence of the operations of nature. I will pass by the wide field for discussion which this strange philosophy opens to our view; because it is sufficient for our purpose this evening to assume, that, even were the doctrine of predestination established, were it proven that free will in man is a chimera, and the creative powers of his imagination no more than a delusion, still the laws of human action, what we are content to *call* his power of choice, his free will, are so entirely different from and independent of the natural laws of growth and change, that, as compared with the latter, we may logically consider man as possessed of an inherent power of action, independent of mechanical law. And we recognise this power, not only as modifying his own growth and development, but still more clearly in the action of man upon the world which he inhabits, in the creations of his hand and his brain. I have said the tree grows in obedience to mechanical law. Given its origin, and the circumstances surrounding it, and it must of necessity have attained its own particular form and stature and character; that individual one and none other. But the house does not grow in obedience to any such law. It was not in compliance with any such law that there are so many windows in the roof above me, instead of six or seven or any other number. That particular number, and so all the special proportions of this building, were the result of choice and design on the part of the architect, who was free to select or reject as he pleased. And so it is that when we pass from the operations of nature to the works of man, we pass from the world of nature into the world of Art; for Art is a term which embraces every modification in the forms of nature which has been achieved by the intelligence, the imagination, the memory, the creative power, the imitative ability, the skilful ingenuity of man.

What is it, then, which we mean by Art? It is not the mere mechanical combination of matter into new forms, designed for new uses, with which Art deals. Art takes no cognizance of the principles of structure, or the nature of materials, or the composition of the elements which it uses as a language in which to convey its ideas. Art deals only with the images produced, in respect to their beauty or their ugliness; that is to say, in respect to the effect which such images have upon the mind of man; upon that quality of his mind which receives pleasure from the perception of beauty, and pain from the presence of the opposite. And this feeling of pain or pleasure is evoked, not only by the manifestation of beauty or the contrary in material form, but from ideas which have a less material embodiment. It is the images which arise in or are impressed on the mind, in respect to their beauty or the reverse, which, and which alone, are within the realm of Art.

Although Art takes no cognizance of the laws of nature, even when expressing itself in materials subject to those laws, yet it is limited and controlled by them. For example: if you build a house, you must build it in compliance with the law of gravity operating on your materials, or it will cease to be a house; it will tumble down. If you paint a picture you must use pigments and colours which will not undergo chemical change, or your

colours will fade under your brush; the idea in your mind will have no expression. If you would produce a strain of music on a violin, you must rub your bow with resin and not with grease, or your music will remain amongst the eternal silences. If you make a pudding, you must use ingredients which will combine in the manner you expect, or your pudding will curdle, and, as a work of art, will be nothing more than a praiseworthy intention. But still it is not with the material conditions of the work that Art deals. These are within the province of the mechanist and workman, not of the Artist. Nor does Art enquire what are the uses for which a thing is made, nor of its fitness or the contrary, for such uses; further than our perception of such fitness or unfitness may enhance or destroy our sense of beauty. Art deals solely with works *in respect to their beauty;* that is, in respect to their capacity to kindle in the mind that emotion which the contemplation of beauty affords.

When we say that Art is limited by the laws of nature, we mean no more than this—that Art is limited by the possibility of expression in material forms. And all ideas must be expressed more or less in material forms; for even ideas unwritten and unspoken are incapable of being recognised by the mind, except through the medium of language. If we think at all, we think in a language of some sort. Art, therefore, must have an expression; and that expression is subject to the laws which govern the materials which it uses for the purpose. But within these limics, subject only to the conditions thus imposed, the artist roams free and uncontrolled in a paradise of his own fancy, peopled by the creations of his own teeming brain. And so, in and around the material world, and out of elements of which he is himself a part, man weaves a new world, which hangs like a vision around the coarser elements of matter, and by the spells of his creative fancy, he calls into existence the world of Art.

I may seem, by what I have said, to imply, that the idea of material beauty, is wholly independent of the physical laws which rule the operations of nature. But upon this point we should speak with the caution and modesty becoming a very limited perception of truth. For we do not know that there may not be some necessary connection between the laws of nature and the manifestation of beauty. How can we say that the glories of the evening sky are not a necessary result of the same causes by which the revolution of the earth brings the sun every evening on the horizon; which guide the light of the sun through space, and refract it through our atmosphere, and, absorbing some of the rays, transmit the rest in colour to our eyes; which suck up the moisture of the earth into the heavens, and suspend it in graceful drapery over our heads? Who shall say that the solemn beauty of the primeval forest is not an essential and necessary consequence of the laws by which the forest grew? Certain it is that the full development of the powers of life in an individual bears with it a higher degree of physical beauty than the same individual exhibits, when its vitality is impaired by age or sickness. The more perfectly fitted things are for the uses for which they are designed, the more beautiful do they frequently appear. For example, a yacht is more beautiful than a coal barge, even in the eyes of those who are entirely ignorant of the superiority of one over the other as a machine for sailing. I say not that this is a universal law; but I do say that its frequent appearance is sufficient to raise a doubt, whether the production of beauty may not, in some manner of which we can form no conception, be inherently and necessarily connected with the mechanism of nature.

I have said that Art, in the proper sense of the term, does not deal with the productions of man in any other respect than as regards their

beauty. Indeed, the term is often used in a more limited sense, as applying only to works which are produced solely for their beauty—such as pictures, statues, and so on; which are therefore called, *par excellence*, works of Art. But it is clear that the term is capable of a much wider application; because, if we make anything for a special use, if it be only a toasting fork, we can conceive a vast variety of forms in which it may be moulded, all of which may equally subserve the same end, but which may differ widely from one another in ornament and in beauty. In so far as the thing is a machine for doing a particular work, it is beyond the cognizance of Art; but in so far as it is more or less beautiful, it is a work of Art.

Hence it is, that not only objects which are made solely for creating pleasure, such as pictures and statues, but things which are in the first instance designed for physical utility, are equally works of Art. Thus our churches, our houses, our chairs and tables, our fire-irons and our clothes, our carriages and our crockery, all bear witness, not only to the skill of the workman, but to the inventive fancy of the artist; and the graceful curvature of a chignon has no more claim to the dignity of Art than the delicate colouring of a tobacco-pipe; though the one object is designed to enhance the beauty of women, the other the comfort of men; nor does it alter the result that the former as signally fails, as the latter succeeds in its mission.

In short, there is nothing upon which man bestows labour, which does not come more or less within the realm of Art. Hence it is that the study of Art is co-ordinate with the study of mankind. It is not only in monuments and pictures and statues, but in every specimen of handicraft, that we read the history of the people by and for whom they were made. A people thus unconsciously writes its own history in the daily works of its hands. For by these records we learn not only what its workmen and artists could do, but what the people for whom they worked used to admire. The artist not only acts upon, but is reacted upon by the age and race in which he lives. When he aims at producing the beautiful, he is influenced by the consciousness of what his patrons, the public, will accept or recognise as beautiful. It is the same with the poet. In his creations, the poet unconsciously assimilates the standard of his readers. If he describes a hero, he describes a character such as his age and race recognises as heroic. Thus Homer has not only handed down to us poems which have for centuries commanded the interest and admiration of mankind, but he has preserved to us for ever the great historic fact, what was the true type of a hero in the mind of an ancient Greek. And thus, too, the legends of King Arthur's table teach us what was regarded for centuries in England as the highest standard and model of chivalry. So it is in Art. From the works of past ages, we learn what sort of thing it was which a people admired at the time those works were produced. And it is owing to this sympathy between the artist and his race and age, that we trace a distinctive character in the Art of the different nations of antiquity, which can never be mistaken for one another. Thus the Assyrian, the Egyptian, the Greek, the Roman, the Saxon, the Byzantine, the Moorish, and so on, all present peculiar characteristics of style and design and workmanship, which are easily recognised. And there is, moreover, a sort of relation, which it is far easier to appreciate than to describe in language, between the productions of the artist and those of the poet and the historian of the same age and people. Perhaps the most striking instance of this is that presented by the Assyrian sculptures discovered by Mr. Layard, and now in the British Museum. Often have I been powerfully moved when gazing on those strange monuments, made, as they are, of the most perishable material, and yet almost miraculously preserved for us for more than two thousand years, by being buried in the warm and dry sand of the desert—often have I thought that

those very monuments had been, no doubt, seen by the Prophet Ezekiel himself, when he penned his inspired visions on the banks of the River Chebar; and that the artistic forms by which he was surrounded impressed themselves upon the peculiar imagery in which he delivered his divine message to his captive race. The unity of feeling, of fancy, of imagination, between the language of Ezekiel and the marbles of Nineveh, is too obvious and remarkable not to strike any one who has carefully studied them together.

And thus we read in the material works of Art, as in the creations of the poet, the character of the imagery, the style of workmanship, the type of ornament, the sort of ideas, in fine, in which, the people for whom the work was made were accustomed to seek the gratification of that yearning for the beautiful, which is one of the ruling powers of the human soul. The most barbarous people has some sort of perception of the difference of forms, in respect of their beauty; and seeks, it may be in very grotesque ornament and distorted images to gratify its capacity for admiring. And so it leaves behind, in the works of its hands, a record from which we may infer somewhat of the character of its mind, and the state of its civilisation.

But not only do we find a perceptible difference in the character of the Art of different races, but there is also a history in the Art of each. There is a distinct law of growth and change, of culmination and decay. In no Art is this history so distinctly traceable as in the Greek and the Roman. The Roman, indeed, may be regarded as merely an off-shoot and product of the Greek; for in Rome, Art was exotic and imitated, not indigenous. And this, no doubt, arises from the fact, first, that no other race has left us anything like the same number of works of Art extending over so many centuries, in coins, and gems, statues and vases, made in imperishable materials; and secondly, because no nation ever approximated to the Greek in the perception and love of the beautiful; and therefore in the Art of no people is there the same difference between its worst and best works. Now we find one remarkable law pervading this history of Art; namely, that it grew with the growth of a race, and decayed with its national vigour. And this is by no means accounted for by the increased wealth which accompanies national prosperity; for neither a man nor a people can do more than it is in them to do, because they get more money for it. There is, besides, abundant evidence, that the standard of Art and the perception of beauty do not rise and fade with mere wealth. Long before the time when the wealth of the Roman began to decay, he had lost the only inspiration he ever received from his Greek master; and his Art was rapidly degenerating, when his wealth and luxury were at their greatest. But with the Greeks, the growth of their race, not only in the parent States but in all their numerous colonies which studded the coast of the Mediterranean, from the Pillars of Hercules to the valleys of Lycia, is written in indelible characters upon their Art, from the earliest ages to the culmination of their glory in the age of Pericles; and in the same language, the decay of national life after the time of Alexander the Great, is recorded with equal fidelity. And so well ascertained is this law of growth and change, that the archæologist is never at a loss to assign to any work of Art, the approximate period, in which it was produced. If you take the series of coins of any one city, such as Thurium or Tarentum, in Magna Græcia, on which one type occurs throughout, you get the most perfect illustration of the growth of Art. The common type on the coins of Thurium was a rushing bull; on those of Tarentum, on the obverse, a horse, and on the reverse, a boy riding on a dolphin. In the earlier part of the series of these works, you find the first attempts of the artist to express his idea. The character of the work is hard and crude, but thoroughly honest and conscientious. You can see that the artist is doing his best. He never slurs an outline, but always renders it distinctly. There is no flow

in the lines, they are rigid and unyielding. They are like the first lispings of the child to speak; the effort is great and the success imperfect, but you feel that it is but lisping; it is not the language the child will one day talk. As time goes on the work improves; the skeleton is filled in with flesh, the detail is elaborated. The artist gets a more complete mastery over his subject, but loses none of his truth; for it is evident that he is still taking his inspiration from Nature. Recollect, I am not speaking of the life of one artist, but of the operation of many cycles of years. Each artist deals with the same type, sacred to his city from its relation to its mythical traditions, but he does not copy from his predecessors. He works in the studio of Nature, and owns no other master. And so, at last, you have in some of these little silver coins, no larger than a shilling, some of the most glorious works of Art which the world has produced.

It was this character of faithfulness and honesty to his Art and his subject, which was the peculiarity of Greek, as it is of all truly great Art. Take, for example, those marbles which stand unrivalled in the artistic efforts of mankind—the groups from the Pediment of the Parthenon, now in the Elgin Gallery of the British Museum. These statues stood more than forty feet from the ground; they were somewhat larger than life size; and they stood, of course, against the wall of the pediment, so that one side only could be seen, and that from a distance. And yet you find that, not only in front but behind, the same wonderfully elaborate and detailed work has been devoted with the most lavish and ungrudging honesty. The hard and brittle material vanishes from sight as you gaze; now melting into softest flesh, which seems as if it would yield to the pressure of the hand; now ossifying into bone; here quivering in a muscle, there palpitating in a vein. If we be inclined to say—why waste so much labour on a work, so much of which was never to be seen? I reply, the man who had failed so to work for the unseen, would have been incapable of producing what was seen; for the true artist works, not for gain or for applause, for vanity or for fame, but in a pure, unselfish, and absorbing love of his Art, and in reverend adoration of the spirit of beauty which he worships. And in Ancient Greece this passion for Art was no doubt elevated and intensified by the feeling of religion. It was not in painting portraits of one another's faces, and chronicling imperfections, but in striving to realise forms fit to impersonate the gods, that Art attained its highest perfection.

If we turn now from the period of growth and culmination, to that of decadence, we find the picture reversed. The lines are no longer wrong through unsuccessful effort, but through careless neglect. The artist, instead of going to Nature for his inspiration, is evidently only copying from his predecessor, and his expression becomes wavering and indistinct. The outlines are slurred, and the faults of the past repeated and exaggerated. The character of the work becomes sensuous as the feeling becomes superficial. The sacred type has changed from a faith to a fashion; and so the artist's right hand loses its cunning, and can no longer grasp the idea, when the soul of the idea itself is passing away. There is one most remarkable instance of this history of decadence in the barbaric imitations of the coins of Macedon. The common type upon the coins of Philip and Alexander was the head of some deity personifying the King, or rather the head of the King in the character of the god, bound with a fillet of laurel leaves. Barbarous races seem to have copied this type from one to the other, until at last the original type became so indistinct that it was lost. There are ancient British coins, in which the head consists of nothing more than some rude lines and dots; and it is only by seeing a whole series of these coins at once, and tracing the deterioration down from one to the other, that you can believe that a head is intended at all. Amidst

this chaos of marks, the laurel wreath, being the easiest to copy, remained somewhat more distinct, when other parts of the head had disappeared; and there are some curious coins of Cunobolinus, one of the kings of Britain in Roman times—the Cymbeline of Shakespeare—in which some artist, evidently a genius in his way, finding these curious marks on the coin he had to imitate, and not liking to imitate what he did not understand, assumed that they were meant for an ear of wheat, and reproduced an exceedingly good representation of an ear of wheat, evidently taken from Nature. Thus, in the course of time, and by the decadence of Art, the head of Philip of Macedon is changed into an ear of wheat. A singular analogy to the cynical philosophy of Hamlet.

I will not delay you by applying these principles, as I might, to the Christian Art of the Middle Ages, but you will at once perceive what a close analogy there is between the archaic character of the early Greek Art which I have been describing, and that of the Italian masters before the time of Michael Angelo and Raphael, which may be considered as the culmination of Christian Art. You are all now familiar with the character of this early style, from its revival in recent times under the name of the Pre-Raphaelite school.

Taking, then, these two great principles:—First, that the Art of every race has a distinctive character of its own, which follows it wherever it goes; and, secondly, that the Art in each race undergoes a steady and perceptible change, either for the better or worse; it is apparent how powerful an auxiliary the study of Art becomes, to those who are seeking through other channels an insight into the history of the human race. The philologist traces the several streams of mankind up to their parent fountains, by analyzing their language, and discovering from what source its first elements, its bases, its roots, were derived. The comparative anatomist pursues the same enquiry by studying the minute peculiarities of his physical structure, the form of his skull, and the proportions of his limbs. But the student of Art follows up the investigation by an independent course. He takes the works of the hands of a people, and forces them to tell their faithful, because unconscious, story as to the sources from whence they derived their traditions of taste and of feeling, their modes of interpreting or representing the beautiful, the character of their ornament—in a word, from whence they derived the symbols and standard of their Art.

I cannot pass from this part of my subject without expressing my conviction, that the machinery thus provided by the study of Art might well be put in motion, and brought to bear upon the very interesting subject of the origin and cradle of the aboriginal inhabitants of these islands. We have a considerable number of works of Maori Art; the most interesting of which is the *runanga whare* of Tauranga, which is fortunately preserved in this Museum. And there are preserved amongst us a considerable number of canoe heads, spears, and other weapons and vessels, mats, and so on, which must have been produced at the cost of considerable skill and labour. Now, it is obvious to the most casual observer, that there is a similarity of ornament and design and workmanship running through all these objects. The two great questions which we might, by a sufficiently extended study, be able to decide are—where does this Art come from? It was not created in New Zealand for the first time. It was no doubt displayed on the canoes and the arms of the warriors who first landed on these shores; and I have no doubt that it might be traced up, through all its changes amongst the Pacific Islands, to its cradle on the Continent of Asia. I think it not unlikely that a study of the works of the country from which it springs, would enable us to judge, with fair approximation to the truth, of the date at which the Art now existing in New Zealand was severed from its parent stem in Asia. This is a work, which, so far as I know, has yet to be undertaken. And the first step towards it is to bring

together into one Museum such as this, a sufficient number of objects of all kinds, arrayed, so far as possible, according to the dates of their production. The latter is, of course, the greatest difficulty. But an object whose approximate date is known, is worth a dozen about which we know nothing. Every effort therefore ought to be made to collect those objects, such as spears and meres, which are known by the Maoris to have been in existence for several generations. I think it quite possible that enough might be done to establish something like the law of change in Maori Art; and then we should be able to answer the second question;—is this an Art in advance or decay? Is it in a period of growth or of decadence? Is this grotesque ornamentation the work of a people struggling out of primitive ignorance towards a higher perfection? or is it the fragment of a higher art from which the soul has departed, and of which the traditions have been imperfectly preserved, by a people which has relapsed into barbarism? I venture not to offer any theory upon the subject, but I cannot but think that the subject is one full of interest and instruction, and that it is within the scope of such an institution as this to collect the materials which shall enable some competent archæologist to do for Maori Art, what Sir George Grey has so ably done for Maori literature.

I have endeavoured to show the relations in which Art stands to physical law, and to explain its limits. I have also shown how it is incorporated into and forms an important part of the external history of man. I proceed now to enquire what are the relations which exist between Art and the subjects of the other intellectual and moral powers of man.

That upon which Art is based, without which it could not exist is the natural and inherent capacity in man to distinguish the beautiful from the ugly;—that quality in his soul which has an affinity for the one, and revolts from the other. And I lay this down as an undeniable truth, that such a capacity is an essential part of the organization of man, in spite of the fact constantly presented to us, that not only individual men, but whole ages and races of men, have derived pleasure from forms and ideas, which to other men and other times have been utterly painful and repugnant. Hence it is that, even amongst cultivated men, we hear the heresy constantly repeated, that Art is all a matter of taste, and that that is beautiful to each man which he feels to be so. And so upon no subject, except perhaps religion, is there so much unsettled opinion as in matters of Art. In the philosophy of Art, as in religion, men range between the extreme limits of a superstitious reverence for authority on the one hand, and, on the other, a sceptical rejection of everything outside an individual, and mostly an ignorant, private judgment.

But does it not seem a sounder philosophy to believe that this great, distinctive, and powerful capacity of the soul—this affinity for the beautiful—is cognate to other capacities and powers of our being? We have a capacity for distinguishing abstract truth from error; and we do not doubt that truth is truth, and error error, because the majority of men are only partially capable of perceiving the distinction. We have a capacity for distinguishing right from wrong in morals; and we do not conclude that there is no right or wrong, because whole races and generations of men have failed to recognise which was which. Why, then, should we argue that there is no standard or test of the beautiful beyond individual and undeveloped judgment? Man does not create the essence or principle of beauty, any more than he does that of abstract truth, or of moral goodness. He only recognises it and assimilates it. If he fails to do so; if he takes that for the beautiful which is not so; if he worships false gods; it is not that the nature of the object is altered, but that his powers are either undeveloped or depraved. Is it not rather the case that all the spiritual and intellectual organs in man are subject to the same law which obtains in the material organs of all animated nature, in that they are

more or less perfectly developed by circumstances, and grow by use and cultivation?

Most of these difficulties vanish if we realize the distinction between the real and the ideal. The ideal is that type to which the real ever tends, as the curve to its asymptote, and the infinite series to its sum, although the one never reaches the other in finite time and space. If you take every oak leaf upon an oak tree, you will perceive that they have all one type, although they all differ from one another. You can conceive the *idea* of an oak leaf having that perfect form towards which each individual tends, but of which each falls short, some in one particular, some in another; but which the imagination seems to grasp, as the possible perfect form of the oak leaf in its full development. I have already noticed the perfection of Greek Art; this it was which was the key to its excellence—that the artist sought, by the study of the imperfect individual, to reach the conception of the ideal, and so to symbolise the idea of a god under the material form of a perfect man.

If, then, we would emancipate ourselves from the difficulties which so often entwine us in æsthetical as well as ethical questions, we must shake off the trammels which imperfect development casts around every subject, every idea, every faculty; and endeavour to look, not from the lower standing ground of the real, but from the loftier region of the ideal. Thus we shall recognise that only to be perfectly and eternally true, which man, in the most perfect development of his intellectual faculties, would recognise as such. We should accept as morally right, not that which may seem to man, living under provisional and circumstantial law, to be so, but that which man, in the full perfection of his moral faculties, would acknowledge as a perfect moral law. And so we shall receive as a standard of true excellence in Art, and regard those only to be manifestations of perfect beauty, which man, in the ideal and perfect development of his æsthetic capacity, would feel to be in perfect affinity and harmony with his power of appreciating the beautiful.

But I would endeavour, if I do not weary you, to trace even further the relations which may possibly subsist between, subjectively, the intellectual, ethical, and æsthetical powers in man; objectively, between truth, goodness, and beauty, in the harmony of things. It seems to me, that prior to the conception of all created being and all action, and, *a priori*, prior to the idea of matter, we must conceive some necessary law or principle underlying and pervading the whole structure; underlying, as it were, the possibility of any scheme of creation whatever. Such a principle seems to me to be—*the law of truth:* and by *truth* I mean perfect consistency—the perfect harmony of part with part, and of every part with the whole. This is, if we consider it, the widest and most accurate definition of truth. Its absence involves the idea of something more than chaos—of an impossibility of existence at all. This idea of truth seems to be the essence of all possible schemes of all possible creations. The dogma that "God is truth," which we reverently receive as in harmony with our instincts in religion, is not only the assertion of a fact, or the attribution of an incidental quality to the Deity: it is the enunciation of a necessary philosophical law. Without the law of truth, we are incapable of conceiving that a universe could have been created, or a God could have existed to make it. Now we first come in contact with this principle of truth—involving the idea of its co-relative untruth—in abstract reason. And we have a faculty or quality of our minds, our pure intellect, which recognises and accepts this law in matters which are independent of all action and of all matter. But the moment the idea of a being capable of action is introduced, it follows that the quality of his action must be determined by the same all-pervading law. Moral goodness, therefore, is truth in action: it is the operation of truth performed upon action: or to use a mathematical formula,

goodness is truth multiplied into action. As yet our reasoning has not involved the existence of matter at all; but no sooner does the idea of matter arise, with all its sensive attributes of form, colour, sound, and so on, than we are compelled to enquire, how this new economy is affected by the omnipresent law in subordination to which it must have been created. The character or quality of form must be determined by the same rule. In other words, the operation of truth performed upon form, is beauty; or to use the same mathematical formula, beauty is truth multiplied into form. I use the word form of course as comprising every external quality of matter by which it becomes present to the mind. If this be so, then, the true, the good, and the beautiful, are no more than the three different manifestations of the same one law, which are recognised by the three spiritual faculties in man, his pure reason, his moral judgment, and his æsthetic power. Having once recognised the idea of truth in the abstract, goodness is truth in action; beauty is truth in form.

And it is curious to observe how this identity between the three seems to be witnessed by the unconscious testimony of language. In our daily communication of thought we are in the habit of interchanging the words by which we express intellectual truth, moral goodness, and physical beauty; as if we were secretly conscious of a unity of idea or principle pervading these three objects which operate upon our different spiritual powers. Thus for example we talk of a *good* man, and a *good* picture—meaning by one moral excellence, by the other beauty. Again we speak of a *good* bargain—meaning a bargain consistent with its object, to make money; and we should equally use the word good, if the character of the transaction had been the reverse of good morally. Again we speak of the *truth* of a painting; and the *beauty* of a mathemathical demonstration; and of the *beauty* of holiness; and we tell a boy at school that it is *wrong* to tell lies, and that his sum is *wrong*. Now I say that these unconscious witnesses of language are not unimportant, as testifying that there is a real connection—a common principle, underlying our ideas of truth, goodness, and beauty; so much so, that we seem unable to express our full perception of the one, without borrowing the language we have already assigned to the others. At all events, should this seem to you but a fanciful analogy, I plead that it is no unworthy object to endeavour to trace out one additional thread in the complex fabric of creation, or to elucidate some fresh view of the manner in which the worlds of thought, of feeling, and of matter, are bound together by one common principle, and so minister to the divine and eternal harmony of the whole.

If time allowed me, it would be my task to pass under review the various arts in which men have sought to gratify their perceptions of the beautiful, and to show how the principles I have been endeavouring to elucidate are applicable to all alike:—Arts which may be called those purely of the imagination, such as poetry and prose writings; which come within the region of Art, in so far as the modulation of the idea and the choice of expression appeal to our sense of pleasure, and are adopted with regard to their beauty: the art of oratory, in which the ideas are not only conveyed in written language, but the pleasure is enhanced by the melody of speech:—music, which like oratory, consists of two arts—the art of the composition, by which the master developes his idea and expresses his feeling by a disposition of possible musical sounds; and the art of singing or playing, by which these possible sounds receive utterance in vocal or instrumental music:—statuary, painting, and architecture, which deal with matter in its form and colour:—and even the arts which appeal to our touch—our taste—such as eating, drinking, and smoking, which must claim their place in the realm of Art, in so far as there is a greater or less degree of pleasure to be derived from the combination, situation, and treatment of the materials which subserve to their uses. But

time would fail me in the attempt. I will therefore very briefly refer to that one art, which more than any other is within our reach in this country.

All Art in a country like this, in which the whole time, energy, and interest of the population is devoted to business and to the accumulation of wealth, must be in a neglected condition. Of pictures and statues we have comparatively speaking nothing. Poetry we can have as much of as each man wishes, in an age in which books are within the reach of all. Of musical composition the same may be said ; but of musical performance I can only say, that if we are to accept the critiques which I see in the local papers, there is nothing more to be desired. Over the Art of dining in the colony I draw a veil. It seems to me a subject to be spoken of only as amongst the sacred memories of the past.

All these Arts we engage in as our tastes or our powers suggest. But one Art there is, which is forced on us of necessity. We may or may not hang our walls with pictures, or adorn our vestibules with statues ; but we must have walls and vestibules of some sort. We may or may not indulge in music ; but we must have rooms to practice it in ; or if we confine our efforts to the serenade, we must have ladies' windows under which to breathe our amorous strains. Over three-fourths of the earth's surface, the existence of an animal of a constructive mind but a thin skin, clothed with neither fur nor feathers, involves the construction of some sort of shelter ; and out of that necessity of his nature grows the Art of architecture. Again, there are two features in architecture which give it an importance peculiar to itself. First, that its works are durable, and secondly that they are public. They are not like the production of musical sound, or the enjoyment of a feast, things that are gone and remain only in the memory ; nor like clothes, which are perishable and change with the fickleness of fashion. Almost the most perishable structure outlives its builder. And they are public, not private. Your pictures are shut up in your own rooms for the enjoyment of yourself and your friends. Your music is mostly practised in the privacy of your own houses. But it is not so with your house. Once build it, and as a work of Art it ceases to be yours. It belongs to all alike. The bricks and mortar, the wood and the iron are yours, but the form, the image, the Art, is the property of every beholder. The humblest peasant who gazes on the vanes and pinnacles of the neighbouring mansion, as he rests from his labour under the evening sky, can derive as much pleasure from the sight as its lordly proprietor. You can levy no protective duty upon the admiration of your neighbours. You can take out no patent for the monopoly of the enjoyment of beauty. No action for libel will protect you from the rude criticisms of offended taste. Therefore is architecture above all others the catholic art, and more than all others reflects and expresses whatever a nation may have in it of the power of creating the beautiful. And so, on the other hand, there is involved in architecture a responsibility which does not attach to the productions of other arts. You may hide your little ugliness in your own chambers, and sing out of tune in your own boudoirs, and indulge in tawdry ornament and worship a false fashion in the privacy of social life ; but you do not thereby poison the public taste, or pervert the popular judgment. But you cannot erect forms upon which for long years the eye of the public must rest day by day and hour by hour, without more or less moulding the feeling of the community at large. Whether you wish it or not, every house is a lesson, every town and village a school in art. The extent to which the popular taste becomes moulded by the impression of what is daily before its eyes, is evidenced by the distinctive character which particular towns, villages, and districts acquire in the course of time. Not that all the buildings are the same, but that there is a certain unity of feeling which pervades them all, and which gives a special character to the whole which it retains for ages.

I have heard it said,—"of what use is it to devote money or labour to an architecture in perishable materials, in 3 × 4 scantling and inch boards?" I reply, first, that wood properly used is by no means so perishable a material as is generally supposed. The church of Beover, in Cheshire, which was restored some years ago, is one of the noblest specimens of the mediæval wooden architecture of England. It was built, I believe, about 1350, and is in perfect preservation. I have heard there still exists a small chapel of oaken logs in which the body of St. Edmund was laid one night on its journey to Bury St. Edmunds, where it was buried. That was in the ninth century, a thousand years ago. Many of our finest roofs are many hundred years old: witness that of Westminster Abbey, built by Richard II. The spire of old St. Paul's, which was burnt in the fire of London, having lasted nearly four hundred and fifty years, was 500 feet high, and was entirely of wood.

But even were it so, I reply that your house itself may perish, but the *idea* does not perish; the effect on the public judgment is imperishable. If your house be false and hideous, it has diffused its ugliness into the hearts of all beholders for the period of its short but noxious existence. It has to a certain extent incapacitated the public mind from appreciating nobler forms. If you build ugly houses in wood, your children will build uglier houses—were that possible—in stone. All architecture was originally wood. The marble temples and porticos of Athens never lost the forms which were derived from their original wooden construction. England had a wooden architecture specially adapted to her climate, of remarkable beauty. In the perishable structures of earlier times are laid the foundations of that true and cultivated sense of the beautiful, out of which alone a noble Art can arise of more costly and permanent materials.

Now I cannot at present even glance at the sources of beauty in architecture, but I may indicate one principle which follows from what we have dwelt on this evening. One principle there is, from which there is no exception; that falsehood, sham, pretence, vanity, are incompatible with all that is great, noble, and beautiful in Art. I will take two instances of what I mean, derived from the architecture of this colony. First, the attempt to imitate stone in wood. This pervades the whole character of our Art. Even our construction is borrowed from stone. I see buttresses to our churches, which, were they of solid stone, would have been a source of strength; but which, being no more than hollow boxes of inch board, covering a prop or strut, are of compartively little use. Secondly, all the mouldings and ornaments are borrowed from stone, and look well enough as long as they are new; but when the varnish is gone, and the paint cracked, and the wood distorted and shrunk, which very soon happens, they look tawdry and dilapidated. We adopt a style of ornament applicable to stone, but which cannot be durably rendered in wood. The result is that our towns look as if they had got up late after spending the past night in dissipation. Again, we complete the whole by painting and sanding the boards, and working the edges so as to make the wall look like stone. And so our building stands staring us in the face with a perpetual falsehood, and one which we can all the time detect. Now whatever we may think of a lie, surely an unsuccessful lie is the most contemptible of human efforts.

One more instance I will take, and it shall be the last. The noblest form in architecture is beyond doubt the gable; running, where both faces are equal, into the pinnacle and spire. The gable naturally rises out of the necessity for throwing the rain off the house-top by a sloping roof; and we have seen in the earlier part of this discourse, that it is out of such necessities that the most beautiful forms frequently grow. But in street architecture it is often more convenient to place the ridge of the roof parallel to the street, in which

case the line of the eaves or the parapet of the gutter forms a horizontal line. Now a horizontal line cutting the sky is always a somewhat distressing form; except in the case of the sea horizon, where the infinite delicacy of the ruling, and the immensity of the object, enwrap the feelings and overawe every subordinate sense of pleasure. The horizontal line of the parapet is, however, bearable without offence where it is natural and consistent with the whole idea of the building. But I see frequently in all our towns, a gable turned to the street, and a large dead wall of scantling and boards built up to conceal it. A deliberate and wilful determination to hide the more beautiful form by the less beautiful;—false in construction, for it weakens the house materially by exposing a needless surface to the wind; false in economy, for it costs money without increasing accommodation; utterly false in Art, for it is a miserable sham in every aspect. What then is it for? It is to gratify a false and ignoble vanity. It is to make the house look bigger than it is. I stand opposite such a building, and it seems to say to me, "Now, look at me. You see I am a good substantial two-storied tenement, with an upper storey about ten feet high, and a comfortable upper room with a window in the middle of the wall;—a building of which my architect and owner may well be proud." I reply, "Friend house, you are a complete humbug. That square front of yours is for the most part exposed to the blasts of heaven, behind as well as in front. You are in a great measure not a house, but a signboard, a hoarding stuck up in the air. That square window is not in the middle of the wall of a large and comfortable chamber, but of a wretched garret, and has been with difficulty squeezed in between the sloping rafters. You are not a two-storied house, but a cottage with one floor and a cockloft; and as a work of art, you are everything that is odious and contemptible."

The one class of buildings which most awaken my feeling of the beautiful, and they are now very rare, are those small unpretending tenements which were built by the early colonists; some of them not ungraceful in their proportions; all of them possessing the beauty of simplicity and truth, devoid of vulgar pretension, tawdry vanity, and inappropriate ornament.

And I cannot but take this opportunity of earnestly impressing upon you the great responsibility which rests upon the Government of every country, to erect public buildings which shall elevate and educate, instead of depraving the public taste. If a Government represents, as it should do, whatever there is of worth and nobility in the nation; if it be, as it ought to be, an impersonation of the strength and wisdom, the knowledge and the feeling of the people; so ought it, in the public works which it undertakes, to reflect and embody the great qualities of which it is the representative and depository. But besides this, it should ever bear in mind that the external symbols of power are not the expression of a love of pompous or idle pageantry, but arise out of the consciousness, that human nature requires that power must ever present itself to the public in the habiliments which may remind men of the respect and homage which are its due. It is not power in palaces which we have to dread in these countries and in this age: it is power in the tavern and the hovel; and I cannot but tremble for the life of authority which a nation is content to deprive of the external symbols of respect.

Gentlemen, I conclude this long and uninteresting discourse, by entering my humble protest against the sacrifice of public honour and dignity to private wealth and luxury; by entering my protest against the vices of an age which subordinates its love of the beautiful to its worship of wealth; which prefers false glitter to true taste; which makes Art the advertisement of riches instead of their crown and glory; which wears false hair, false jewels, false gold; which makes one storied houses look like two storied houses; whose tastes and whose arts are essentially vain and selfish. I would deliver my own soul by proclaim-

ing, that truth is the one element in Art, as in all that belongs to man, without which he can produce nothing that is permanently great or noble.

And I would suggest to your earnest consideration, whether, having not only been placed by our Creator under the authority of a moral law, but placed also by the same power in the midst of a world teeming, from the infinity of greatness to the infinity of littleness, with forms of unspeakable majesty and beauty, it may not be a mistake greater than most of us suppose, to neglect, individually and nationally, the study of this principle of beauty for the recognition and enjoyment of which we are specially adapted by our nature.

MAN'S PLACE IN CREATION. By C. W. RICHMOND, One of the Judges of the Supreme Court of New Zealand.

[*Lecture delivered in Nelson, June 25, 1869.*]

MOST of you are, no doubt, aware that Modern Physiological Science is by some persons thought to throw strong light upon the subject on which I am proposing to address you : MAN'S PLACE IN NATURE. It has at all times been, in a vague way, admitted, that, in respect of his corporeal frame, man is a member of the Animal Kingdom. But, it is undeniable, that recent science tends to bring home more thoroughly the fact of this connection with the lower creatures; so that, to many well instructed persons, that being, who, in the eye of Faith, once seemed to rank only a little lower than the Angels, now appears, viewed in the light of modern speculation, hardly removed one grade above the Apes; and, just as much as these, the creature of material necessity. Thus, the great questions of the Nature and the Destiny of Man, heretofore thought exclusively the property of theologians, seem to be brought into close relation with modern physics. It is my purpose to investigate the character of this relation; the real bearing, in other words, of Natural Science, in its present aspect, on those intensely interesting questions of "Our Whence and Whither."

I know it will be thought by some a highly dangerous course to move this matter. I know the dread, sometimes avowed, but much more often felt without avowal, that such inquiries must certainly confuse our thoughts, and, very likely may perplex our lives. But who is ignorant that, at this very moment, the literary world resounds with this discussion? Who can close his ears to all the loud debate now going on; or can refuse to hear conclusions, fatal to every form of Human Faith, yet drawn triumphantly, and, (so the reasoners think) with logic not to be evaded, from premises supplied by the undoubted science of the day? Amongst the young the most inquiring minds cannot be kept in ignorance about these things. Their elders, if they please, may try the ostrich plan of safety for themselves, or may draw back, like blinking owls from the unwelcome daylight. But in these days of universal reading mere reticence in Church or Home will not avail. Come good, come ill, the best and manliest minds will strive to sift the matter to the bran, and try conclusions for themselves. There is, then, nothing for it but that those who would uphold the ancient faith in God and Man should don their armour, and go down to battle with this newest foe; unless, indeed, they wish to see materialists in sole possession of the field of thought, free to impose their dreary creed upon the coming age. Divines in vain protest that Man is no fit subject of Zoology. The Naturalists refuse to be warned off the Human ground. In virtue of man's physical frame they claim him, and will keep him in spite of all objectors, as a subject of their science; and to me it seems expedient at least to listen to them, and learn what they have to say. The faith that hides its head from all opposers is scarcely worthy to be called a faith.

My plan, of course, requires me to begin with some succinct account of those researches to which I have alluded. The compass of a single Lecture (not to mention my own want of technical knowledge), will not admit of more than a broad and rapid sketch, or, as I fear I rather ought to say, a meagre

outline, drawn by no master's hand: yet even such an outline may, I trust, suffice for my main purpose.

The branch of physics most closely connected with our subject is known as Comparative Physiolgy. In this department of physical inquiry the ultimate object is nothing less than to discover the plan of Organic Nature in both the great kingdoms, the Animal and the Vegetable. The special instrument of inquiry is collation or comparison of one organic form with another, with a view to ascertain the characteristic of each, and thence to infer their relation to one another, and to the whole organic world. This science, like every other part of physical investigation, assumes, of necessity, the existence of a general plan or scheme of things; a plan or scheme towards the discovery of which the Human Intellect is capable of advancing. What then has this science to say on the subject of our inquiry.

In the comparison of organic forms the first great division which presents itself is that already noticed, into Animal and Vegetable. So vast is the difference between the more highly organised members of either kingdom—take for instance a Lion and an Oak-tree—that the untrained mind at first refuses to conceive of a possible relation between such diverse forms. Yet when compared with inorganic matter, with clay or granite, it is seen at once that beast and tree resemble each other in presenting, though under such different aspects, the grand phenomenon of vitality; and we express this very simple fact when we say that they are both alive. Science has revealed in detail many points of resemblance between Animal and Vegetable organisms. In both, provision is made for nutrition, and for the reproduction of the species: both also possess an apparatus for the circulation of the nutrient fluid, and for respiration. And, broad as is the distinction manifest between the Animal and Vegetable, when each is highly organized, it is matter of great difficulty to discriminate between the lowest forms of the two kingdoms. Common observation recognises this in the designation, "Animal-plant," popularly applied to the sea anemone, and other creatures of the same class. The great vital divisions may be likened to two stems of a tree which divide close to the ground: as the topmost branches of each are those which have the least connection, so does the highest vegetable seem farthest removed from the highest animal organisation. On the other hand, the two kingdoms seem to coalesce at their respective bases; just as do the stems of the tree at the point where they branch out. Now, amongst the grounds of distinction between Animals and Plants, there is this possibly essential difference; at all events it is the difference to which I shall specially direct your attention to-night—Plants are destitute of any nervous system.* The characteristic difference hence arising between Animal and Vegetable life is thus expressed by Dr. Carpenter, "The whole *nisus* (effort, striving) of Vegetative existence consists in the activity of the organs of nutrition and re-production; but, on the other hand, the *nisus* of animal life tends towards the evolution of the faculties of sensation, and of self-determined motion; and in its highest manifestation to that of the intelligence and will." So that there is, you see, a kind of life common to both Animal and Vegetable, which the great French Anatomist, Bichat, has termed "*Organic Life*;" sometimes also called "*Vegetative Life*," as being the only life possessed by plants; and there is another kind of life confined to animals, termed by Bichat, "Animal Life;" and which I shall sometimes refer to as "*Nervous Life*." In the animal, the stomach, intestines, and glandular system, and, in some degree, the apparatus for circulation, are organs of the

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* The appearance of nervous irritability presented by parts of particular plants, as by the leaflets of the sensitive plant, and the stamens of the barberry, is pronounced to be due to a different cause.

Vegetative or Organic Life; the brain, nerves, eye, ear, and muscular system, of Animal, or Nervous Life.

The two Kingdoms being thus discriminated, the study of the resemblances and differences presented by Animals has led to the division of the Animal Kingdom into various groups; on the ground that all the members of each group, in certain points, resemble one another, and differ from the members of other groups. The primary divisions are named *Sub-Kingdoms.* Each Sub-Kingdom is divided into *Classes*, the Classes into *Orders*, the Orders into *Families*, the Families into *Genera.* The ultimate Sub-Division is of Genera into *Species.*

The Animal Kingdom is now usually divided into Five Sub-Kingdoms, each under a title, more or less descriptive of some obvious and leading peculiarity of structure. The *Vertebrata* form the highest Sub-Kingdom; so named from the possession of a backbone, or spine, composed of a variable number of small bones, called Vertebræ—as examples of each of its four classes, take the Horse, the Eagle, the Crocodile, the Salmon. The title of the Second Sub-Kingdom, *Articulata*, indicates that it comprises Animals, whose bodies are composed of a succession of segments, arranged in a line—hence called *jointed*, or articulated, *animals*—of which peculiar structure the Bee and the Lobster are well known forms. All the insect tribes belong to this Sub-Kingdom. The Third Sub-Kingdom comprises the *Mollusca*, so named from the softness of their bodies; some, but not all, of these Creatures are protected by a shell. The Slug and Oyster are both Molluscs. The *Radiata* compose the Fourth Sub-Kingdom; and take their designation from the radial or star-like symmetry of their bodies. This form, Carpenter remarks, must in itself be regarded as a Vegetative character, for it corresponds with that which is seen in the disposition of the appendages around the axis in the leaf-buds and flower-buds of Plants. The Star-fish and Sea-Anemone are characteristic forms of the Radiata.* The Fifth Sub-Kingdom contains the *Protozoa*, so called as being the first and lowest form of Animal Life, corresponding in rank with Protophytes in the Vegetable Kingdom. Infusoria and Sponges are members of this group.*

Now, in determining the priority and mutual relations of these great groups, and of their sub-divisions, we must keep in view the principle of Animal Perfection already announced; namely, the degree of Nervous Life accorded to each, and displayed in the faculties of sensation and locomotion; and, finally, in the mental attributes of Intelligence and Will. An animal is high in the scale, as it recedes from, low as it approaches, a mere Vegetative Life. In other words, the more it is endowed with Nervous Life the higher is it to be placed on the scale of Animal Existence. Tried by this test, we find the Protozoa scarcely entitled to rank as Animals. No definite trace of a Nervous System has yet, I believe, been discovered in them; and their claim to be reckoned Animals rests chiefly upon the nature of their food, which consists of Organic substances; (whereas, Plants are enabled to assimilate mineral substances;) and upon their performance, after a strange fashion of their own, of the function of digestion.

It is not until we reach the higher Radiata that we find the first definite indications of a nervous system. Every segment, or division, of these creatures is connected with a ganglionic centre; a ganglion being a little swelling lump or knot of nervous substance; and this centre seems subservient

* Cuvier made only four sub-kingdoms. But his lowest division, *Radiata*, comprises so heterogeneous an assemblage of forms, that later Naturalists have broken it up, and a portion of what Huxley has called the "Radiate Mob" of Cuvier, is now classed as a distinct sub-kingdom, under the title of Protozoa. The arrangement, like every other part of merely physical science, must continue to vary with increasing knowledge.

to its own division alone; at least to have very little dependence upon the other segments of the Animal. In short, to borrow an allusion from our local politics, these creatures may be said to have ultra-provincial constitutions.

Next we come to the Two Sub-Kingdoms, immediately beneath the Vertebrata; and these indeed present a sharp and interesting contrast. On the one hand the Mollusca represent the gradually increasing perfection of the apparatus for the discharge of the functions of Organic, or Vegetative Life—creatures, for the most part, sluggish and inert, yet greedy and voracious; "whose God is their belly"; as Carpenter quaintly remarks of them. On the other hand the Articulata are generally characterised by the rapidity of their movements, the great, and sometimes enormous, proportionate strength of their muscles, the extraordinary instincts displayed by some members of the group, and the large endowment of nervous force with which these various gifts are connected, and on which they are, in a physical sense, dependent. Thus the Articulata represent the gradually increasing perfection of the Nervous or Animal Life.

In the Mollusca the Nervous System is by no means so striking a feature of the organisation. In many of the lower members of the class the mouth is the only indication of a head; the organs of sight, if they exist, are imperfectly evolved. But in the higher classes the case is different. Many of these possess the senses of sight and hearing, and the organs of these senses are collected upon a *Head*, about which the Nervous ganglions are concentrated. But even in the highest class of Molluscs the Nervous System appears subservient to the sensorial and nutritive functions.

Turning to the Articulata, we find very distinct indications of an approach in Nervous structure to the Vertebrata. The characteristic feature is a double Nervous cord studded with ganglia at intervals, there being one ganglionic centre for each segment (or division) of the Animal. The more alike the different segments, the more equal are the ganglia. In the lower classes, all the segments of the trunk being nearly of a size, so are the ganglia; and the power of each ganglion is almost wholly confined to its own segment. In this they resemble the Radiata; the chief difference being that the segments of the latter are disposed in a radiate manner, whilst in all the Articulata they are longitudinally arranged. But in the higher Articulata, the great power of the Nervous System is concentrated about the head and thorax (chest). The ganglia of the head are always larger and more important. They are connected with the organs of Sight and other Special Senses, and evidently possess a power of directing and controlling the movements of the entire body, whilst the power of each ganglion of the trunk is, as already said, mostly confined to its own segment. It is obvious that the double Nervous Cord of the Articulata corresponds with, and as it were pre-figures, the Spinal Cord of Vertebrata; and that the cephalic ganglia (ganglia of the head) correspond with the contents, at least with a portion of the contents, of the Vertebrate skull.

In the class of *Insects* which is the highest of the Sub-Kingdom "Articulata," the development of *pure instinct* reaches its highest point. Ants and Bees are equalled by no other creature in the geometrical precision of their structures, their perfect adaptation of means to ends, and the absolute regularity with which each member of their wonderful societies performs its allotted part in the economy of the nest or hive. And as pure instinct culminates in these creatures, it would seem that the higher Articulata should be treated as a lateral branch of that great tree of Organic Life, of which we have been as it were, tracing the upward growth. In their own line, there is nothing superior or equal to the Social Insects.

Another observation tends in the same direction, it is this: as regards all

the functions of Organic, as distinguished from Animal Life, the Mollusca are nearer Fishes, the lowest class of Vertebrata, than are the Articulata. In continuously tracing the upward course of Nature, we must, therefore, come down again, as it were, from the topmost Articulata in order to regain the main line of progressive development.

Pursuing this course, we revert to the highest of the Mollusca, the Cephalopoda; and here we find the first hint of the structure which gives to Animals of the highest Sub-Kingdom the name of Vertebrata. The Nervous centres of the Insect are protected by firmly jointed rings, which may be regarded as an exterior skeleton. But the Cephalopod, known as the Cuttle-fish, possesses in the bone, which is a well-known article of commerce, the rudiments of a true internal skeleton. If amongst the Articulata we find the first trace of the Spinal Cord, it is here that the bony case which is to hold it begins to make its appearance.

You are of course aware that the Spinal Column, or backbone in Man and all Vertebrated Animals, consists of a series of bones strongly connected together, called Vertebræ. Now the received doctrine of modern osteologists is, that the whole skeleton is derived from the development of the elements of Vertebræ. The Human skull is found to be but a continuation of the back-bone, consisting of four developed Vertebræ. The ribs, and even the limbs, are equally developments of vertebral appendages. Now, what is the significance of this new rigid element in the structure of animals of the highest Sub-Kingdom? If we see a man providing himself with a strong box, we judge that he is getting ready a safe receptacle for treasure; and similarly this new precaution taken by Nature in the structure of the Spinal Column and skull surely indicates that the contents of these parts are of paramount importance in the animal economy—as we know to be the case.

The Vertebrata are divided into four great classes—I. *Mammalia* (Sucklers); II. *Aves* (Birds); III. *Reptilia* (Reptiles); IV. *Pisces* (Fishes). The gradual ascent in type is even more evident in this division of the Animal Kingdom than in the lower part of the scale. This diagram shows how the three superior classes of Mammals, Birds, and Reptiles, rise gradually upwards, each above the one immediately below it, by the improvement of some vital function; each advance implying increased organic complexity and fitting the creature for a higher mode of life.

MAMMALS.

Air-breathing, Warm-blooded, Viviparous.

BIRDS.

Oviparous, Air-breathing, Warm-blooded.

REPTILES.

Cold-blooded, Oviparous, Air-breathing.

FISHES.

Water-breathing, Cold-blooded, Oviparous.

The functions which I have here selected for comparison are, you see, all functions of the organic life; respiration, circulation, and re-production. But I do not mean to abandon that which I have selected as the best criterion of progress in the scale of being, viz., the advancing perfection of the nervous system. The four classes of vertebrates will retain the same relative positions, whether we take as our criterion the perfection of the apparatus of Organic, or that of Animal Life: for the type of Organic Life is raised and improved concurrently with the advance of the Animal Life which it subserves. I have referred to the provision made by Nature in the spinal column and skull for

guarding the physical seats of sensation, emotion, and thought. The inspection of vertebrate forms shows the necessity for this provision in the increasing complexity and delicacy of the Nervous Apparatus, and in its greater importance relatively to the entire Organism. Bearing in mind that the Nervous System of Insects is capable of two great divisions, viz.: (1) the ganglions of the trunk with their double connecting cord, (2) the ganglia of the Head; we find in the Vertebrata that there are gradually developed two additional nervous centres, both contained in the skull. These are called the *cerebellum* and *cerebrum*. So that in vertebrates we may take a general view of the system of nervous centres as comprising (1) the spinal cord with its extensions; (2) the sensory ganglia, or nervous organs of the special senses of sight, hearing, and smell and perhaps of general tactile sensibility; which, collectively, may be called the *Sensorium;* (3) the cerebellum; (4) the cerebrum. The first two, you will recollect, and those only, have their analogues in the Insects and higher Molluscs. From the fact that the greatest proportionate development of sensory ganglia occurs in those tribes of living creatures, I mean the social insects, in which instinct is most powerful, Physiologists infer, no doubt justly, that the physical seat of instinct is in that part of the frame. Now there is, in comparative Physiology, without calling in the aid of other sciences, the very strongest ground for a similar inference respecting the physical seat of intelligence as distinguished from instinct. For, as we pass from one type of vertebrated animal to another we find that the intelligence of the species appears to increase in a just ratio with the increase in the size of the cerebrum; and this organ also becomes, at every step upwards, more and more complex in structure. The inference of course is, that the cerebrum is the physical organ of intelligence. Of the cerebellum the functions seem to be to some extent unascertained. It is largest in man, and appears to be a necessary accompaniment of the expanding powers of the cerebrum. It is generally considered as enabling us unconsciously to combine and harmonise the efforts of a great variety of muscles in complex actions, in obedience to a general volition. We have all seen how a complicated piece of music may be performed automatically, if the piece be well known to the performer; although in learning the piece each movement might have required the exertion of the will. The direction of this sort of automatic action seems to be one, at least, of the functions of the cerebellum, acting in conjunction with the sensory ganglia.

Returning to the structure of the Cerebrum: it is divided into two sections, known as the Cerebral Hemispheres. The Hemispheres occupy quite a subordinate position in the lower classes of Vertebrates—that is in Fishes and Reptiles. Looking, from above, at the brain of a Cod-fish, the sensory ganglia, especially those pertaining to the Organs of Sight and Smell, are very prominent objects, and form the chief mass of the brain. Gradually, as we rise in the scale, the Cerebral Hemispheres assume increased importance, till in the Mammalia they form the mass of the brain, capping and completely covering in the sensory ganglia, and also, more or less, over-lapping the Cerebellum.

The Cerebellum partly shows itself, however, when we look at the brain from above downwards, in every creature except man himself, and those animals which, in general structure, make a close approach to the Human type—I mean, of course, the Monkeys, Baboons, and Apes. In all these animals the posterior lobe of the Cerebrum is well developed, and completely covers the Cerebellum when the brain is viewed from above. So closely, indeed, does the brain of some of the higher Apes approach to that of man, that Professor Huxley declares it to be impossible "to erect any Cerebral barrier" between them. "So far as Cerebral structure goes it is clear," he says, "that man differs less from the Chimpanzee or the Orang than these do even from the

Monkeys; and that the difference between the brains of the Chimpanzee and Man is almost insignificant, when compared with that between the Chimpanzee brain and that of the Lemur." Now the Lemur is recognised as the near relation of the Monkeys. Both are included in the order Quadrumana. Yet it should not be too hastily inferred that these creatures, the Apes and Monkeys, are nearest man in point of intelligence. The intelligence of the Elephant and Dog so far exceeding that of the larger part of the Quadrumana, although their brains are of a type much more remote from the Human, may serve (as Lyell remarks) to convince us that we are yet far from understanding the real nature of the connection of intellectual superiority with Cerebral development.

Time will not allow me to enter into any detail of the experiments which have confirmed inferential reasoning respecting the functions of the various Nervous centres. Suffice it to observe that the paramount importance of the Cerebrum is ascertained by a common experience. Severe injuries to the Human brain which involve the Cerebral hemispheres, whether through external violence, or through disease, are instantly attended by deprivation of all power of manifesting any Mental Faculty. In such cases, when persons recover, it is commonly found that they have remained totally unconscious from the time when they received the injury until their recovery; the intervening period having been a blank in their Mental Life.

Nor can I do more than glance at the Darwinian theory. All existing forms of life, it teaches, may gradually have been evolved in the course of ages, from a very few primal types; perhaps from one only. Mr. Darwin's reasoning has, of course, a bearing on the question of our affinity to the Brute Creation. It goes to show—not indeed that we are descended from Gorillas, but—that Man and the existing Apes may have been slowly developed by change after change from some common form now extinct. Thus, though it is not asserted that our progenitors were Apes, yet it is plain on Mr. Darwin's theory, that these beasts are entitled to put in a detestable claim of cousin-ship to Man.

I do not see, however, that the question of our affinity to the Brute Creation is, in reality, affected by the theory of development. That affinity in truth depends upon the identity of our physical constitution with that of the lower Animals; and this can be established, and is, I think, established, independently of a genetic relation.

On the whole, the general conclusions of Physiological Science, upon evidence of which I have here summarised some portions only, are:—*First*, that the Cerebrum is the Organ, or Physical seat of Man's mental faculties; *Secondly*, that this structure is not peculiar to Man, but is possessed by many of the higher Animals; *Lastly*, that the most highly organised Brutes, the Anthropoid Apes, approach so closely to Man in cerebral structure that it is not possible, in the present state of Science, to establish any anatomical or physiological distinction between them.

I have been able to take no notice of the confirmation added by Geology, or rather by Palæontology, to these conclusions. No scientific man, I had almost said no rational being, now disputes the fact that life existed on this planet of ours for immeasurable ages before the appearance of Mankind upon the scene. Now the operations of Organic Nature through these immeasurable tracts of time, "imperfectly interpreted as they yet undoubtedly are, present," writes Mr. Page, "a series of vital gradation and progress, * * * from humbler to more highly organised orders; as if the great design of Nature had been to ascend from the simpler conception of *Materialism* to the higher aims of mechanical construction; from *Mechanism* to the subtler elimination of mind; and from *Mentalism* to the "still higher attribute of *Moralism*, as developed alone in the heart and soul of Man." Thus; while Physiology shows us this stage of being as now occupied by a hierarchy of creatures;

Geology adds, as a probable opinion, that these creatures have made their several entrances in the order of their dignity. Stranger yet, it seems that each individual member of the higher orders passes, in the embryonic stages of its growth, through a succession of phases corresponding very closely to the great ascending steps of universal Nature. "Because, in the little frame of Man's body there is a representation of the universal and (by allusion) a kind of participation of all the parts there, therefore was Man called *Microcosmos*, or the little world." So writes Sir Walter Raleigh, and the idea which he describes has been treated as a dreaming fancy; but our latest Science tends to establish it as not far off a literal truth.

And now, at last, I turn to make enquiry, how should these facts affect our views of Man as a responsible being, and as a living soul. If it has hitherto been held that man possesses, by Divine ordination, a faculty of determining his own actions within certain limits—free will in short—do the revelations of Physiology consist with this belief? Again, if we have believed that the Mind of Man is an immaterial substance, not of necessity bound to the body which is its present Organ of expression, nor ceasing to exist upon the dissolution of that body, are we required by Physical Science to surrender, or to modify that faith?

It has been proved to demonstration, the Materialist will promptly answer, that Thought, Fancy, Feeling, are merely operations of that aggregation of material particles, which constitutes the Brain of Man. Could we, with adequate knowledge and instruments investigate the working of that organ, can it be doubted that we might trace in every detail those molecular changes which we call the action of the mind? The Past, Present, and Future of every one of us lie packed, they will aver, in that small receptacle, the Human Cranium. Even existing Science is justified in stating, that in the tissues of the Human Brain, all that a Man has been, is faithfully recorded, all that he is, unmistakably expressed, all that he will be, infallibly pre-determined and announced. We await only fuller knowledge to decipher on these fleshly tablets, inscriptions, of an inexorable fate.

In replying to such assertions, feeling is apt to get the start of reason. It is the Heart first, which in wrath, arises and exclaims, "Let Science prove all this"———

"and then,
What matters Science unto Men?
At least to me: I would not stay."

Now my confidence is fixed, that feeling here does not mislead us; that emotion so uniform, so powerful, so pure, as this which springs up to rebuke the cold pedantry of the Positive school has a deep, perennial source in the Reason of Mankind, and the Reality of Things. To express this reason, and give the argument a shape, is by no means easy. That, however, is what I shall try to do; but let no one take my failure for the failure of the grounds I go on.

First then, I say, there is a plain absurdity in the assumption that cerebral phenomena and mental, being concurrent, are therefore identical. If there be such a thing as mind;—and the materialist must not set out by assuming the contrary;—it may be that by the will of God, certain mental events, call them if you please, phenomena, are ordained to run in parallel series with certain physical events; just as if, to give a very simple illustration, two files of soldiers should be moving simultaneously along opposite sides of a street; halting together; again advancing together; manœuvre throughout answering to manœuvre; the companies so appearing inseparably connected in their movements; and in point of fact inseparably connected; not, however, by a physical

necessity, but by the will of the commander, and the discipline of the men. I, for my part, am prepared to grant that every Thought, Emotion and Memory of Man may have its physical counterpart; but the Materialist confounds the physical expression with the thing expressed. The absurdity is as great as it would be to identify the motions of the Telegraphic apparatus with the transmitted message. As those motions are merely the selected vehicles of expression, so may it be,—so is it, as I believe—with the apparatus of the Human Mind. In short, the mistake of Materialism is the old confusion between symbol and thing signified, which has played such wild work in the World.

"It is impossible," says a great philosophical writer of the present day, to "form a steady conception of *thought* except as originating *behind* even the innermost bodily structures, and intrinsically different from them. However much you refine and attenuate the living organism, yet after all, Thought is something quite unlike the whitest and thinnest tissue; and the most delicate of fibres, woven, if you please, in fairy loom, cannot be spun into Emotions. Nor is it at all easier to imagine Ideas and Feelings to be the *results* of organisation, and to constitute one of the physical relations of atoms; and, if anyone affirms that the juxta-position of a number of particles makes a Hope, and that an aggregation of curious textures forms Veneration, he affirms a proposition to which I can attach no idea. Agitate and affect these structures as you will, pass them through every imaginable change, let them vibrate and glow and take a thousand hues; still you can get nothing but motion and temperature and colour; fit marks and curious signals of Thought behind themselves, but no more to be confounded with it, than are written characters to be mistaken for the genius and knowledge which may record themselves in language. The corporeal frame then is but the mechanism for making Thoughts and Affections *apparent*, the signal-house with which God has covered us, the electric telegraph by which quickest information flies abroad of the Spiritual force within us. The instrument may be broken, the dial-plate effaced; and though the hidden artist can make no more signs, he may be as rich as ever in the things to be signified. Fever may fire the pulses of the body: but Wisdom and Sanctity cannot sicken, be inflamed, and die. Neither consumption can waste, nor fracture mutilate, nor gunpowder scatter away, Thought and Fidelity and Love, but only that organisation which the Spirit sequestered therein renders so fair and noble. To suppose such a thing would be to invert the order of rank, which God has visibly established among the forces of our World, and to give a downright ascendency to the brute energies of matter, above the Vitality of the Mind, which up to that point, discovers, subdues, and rules them. * * *"

The position that the action of the Brain, styled, "Cerebration" in the latest jargon of Materialism, is *identical* with Thought and Feeling, must then be surrendered as intrinsically absurd. But next, perhaps, the contention is, that Thought and Feeling are mere *effects of a material cause.* That the bursting of a small duct on the Brain, should, in a moment, destroy the life of Consciousness, and put a stop to every Mental process, is, no doubt, as has been said, a fact of which the significance cannot be increased by the adduction of a thousand like instances. In this, it may be argued, and in the cognate phenomena of Insanity, and of old Age, is the plain proof that Mind is a mere Organic function; suspended when the Organ is deranged, and, on its dissolution, ceasing altogether. Now, in common speech, we do, no doubt, talk of the physical occurrence, the apoplexy, the fever, or the blow, as the very *cause* of the Mind's failure. But, on a closer scrutiny, we find we are not justified in making such an inference. In truth, we have no right to speak at all of a material cause. Of natural phenomena we know *only this, that one event*, improperly referred to as effect, *invariably attends upon, or*

follows, some other event, improperly styled cause. This sounds abstruse; yet I believe, by homely illustration it may be made intelligible; and it is a most important point for the Mind to seize, and keep firm hold of.

Suppose some one watching, in a mill or factory, the slow revolution of a huge wheel, or endless band; and that he could, from his stand-point, command a view of but a small part of the entire revolution, the rest being screened from him. Let one point on the tire, or revolving circumference, be supposed to bear some distinguishing mark, say a number, and other points at certain distances other consecutive numbers. After watching for a time the movement before him, the spectator of course becomes aware of the order in rotation of these numbers; and at the return of No. 1, will confidently expect that No. 2 will come into his field of view, at some calculable interval, according to the speed of the machine. No. 2 he will know, and may predict, will be followed by Nos. 3, 4, and the rest in regular succession to the end of the series. Now, this is exactly like our observation of Nature. We become aware that physical phenomena follow one another in a certain, invariable order; so that the appearance of a known antecedent phenomenon prepares us to expect, and enables us to predict, the appearance in due course of the regular consequent. Or it may be that two phenomena occur together, in which case we know, that when one is perceived the other also is present. *But, more than this Physics can never teach us.* They can never warrant us in declaring that one phenomenon is the true, that is, the efficient, cause of some other of which it is the precursor, or companion. In the case of the revolving wheel, we never for one moment suppose that the emergence of the first marked point *causes* the emergence of that which we know is next to follow. True, in this example, the Mind is not tempted into such a fallacy; since it is known that the real source of the succession we behold is the motive power of the machinery. But the forces which actuate Nature's great machine are beyond our ken. What they do we know, not what in themselves they are. We are not behind the scenes of that great show, and hence are tempted by that law of our Mental structure which will demand a cause for everything, to attribute casuality to what, as far as we know, is a mere antecedent. Nor does it signify, that in Nature *force* seems to be transmitted in each of her operations. Each physical event is but a link in the infinite chain of like events; seeming to stand as a cause of those that follow, but, in truth, itself, but the effect of all that have preceded it—so carrying back the mind "with a never ending regress," in vain search for something which may be rightly called *a cause*. It is as if we should see the balls upon the table, but not the player; and so should foolishly be moved to attribute to mere ivory impinging upon ivory a power which lies not in dead matter, but in some living Will giving the primal impulse.

That Physical Science, apart from mental experience, tells nothing whatever of the cause of Physical events, but merely ascertains their sequences, is a truth admitted by both the great opposing schools into which all modern Philosophers may be divided. Since Hume, all agree that Natural Science is conversant only with the invariable succession of antecedent and consequent, and must disclaim all knowledge of efficient causes, and all idea of necessary connection between cause and effect. Uniform experience leads us to expect that one phenomenon *will* be followed by a certain other, but gives us no right to affirm that it *must* be so followed. Physics in short, have no concern at all with efficient causes; which are indeed explained away, or quite ignored, by the Positive School of Metaphysics. Those Philosophers to whom the Materialist would make his appeal as the only trustworthy authorities, Hume, Brown, Comte, the two Mills, Bain, concur in this; which is the very cornerstone of their Philosophy. The last argument of the Materialist is then as

weak as the first. The phenomena of Disease, Insanity, old Age and the like, give no just ground for the conclusion that Thought and Feeling are mere products of the material organisation. Again I say, the Physical are not shown to be more than *concomitants* of the Mental occurrences; and it is still open to the Theist to refer their connection to the Will of the Almighty.*

I am fully aware that in spite of every argument there will remain on some minds a strong, though perhaps not distinct impression, that the advance of physical science, unfolding more and more as it is doing the boundless plan of creation is decidedly adverse to a belief in Human responsibility. The sources of this general notion are well worth exploration. But I must now limit myself to the narrow ground of the special tendency in this direction of the physical facts I am to-night endeavouring to interpret. Before concluding, I propose, therefore, to say something on the seemingly close affinity to the Brute Creation which the Naturalists have fastened upon us. At the first aspect of the facts on which this unpleasing conclusion is based; when, too, we hear an Owen declare that to determine the difference between *Homo* and *Pithecus* is the Anatomist's difficulty; or when a Huxley affirms, that no cerebral barrier intervenes between us and the Quadrumana; our blood begins to curdle, and for a time, we are on the way to think that the dignity of Man, his awful responsibilities, his Heavenly hopes, alike are dreams of Theologians, which the wiser modern world has now left far behind it. "Yea," say we, in such a mood, "yea, they have all one breath; so that a man hath no pre-eminence above a beast; all go to one place; all are of the dust, and all turn to dust again." And what is worse, we are half tempted to the logical conclusion, "that for a Beast there is nothing better than a Beast's enjoyment," nothing better for a Man than that he "should eat and drink, and that he should make his soul enjoy good in his labour." But rousing ourselves to consider facts, we cannot but perceive the folly of ignoring the immense chasm which separates the reflecting mind, thus debating with itself these arduous themes from the highest of the brutes. Anatomy, it is said, can detect no difference between the brain of a Newton and that of the last discovered Ape. Is it indeed so? So much the worse then for Anatomy! At most it comes to this, that there exist no physical signs of an enormous disparity. But this is no reason for discrediting our own most certain conviction that the disparity does, in fact, exist. A far more likely solution is, that the imperfect methods of the Science are as yet unequal to detect the physical *indicia*. I, for one, am far from thinking that anatomy may not hereafter throw a strong reflected light upon mental science. I say a reflected light, for the original ray divine, the pregnant hint of what to look for, must ever come from Psychology itself. Meanwhile, what folly to surrender our beliefs, because they are not contradicted, but, simply, unrecognised, by the imperfect science of the day. The greater physicists are too wise to forget the limits of their own department. And as to the mere dogmatists of the dissecting room—men, who like Draper of New York, will tell you that those whose fingers have never puddled in the dead brain, can know nothing of the living mind—we must recollect that the "dyer's hand is subdued to what it works in." It is certain that men may, by too gross a familiarity with the secrets of this fleshly frame, "encarnalise their spirits." Look for no wide philosophic scope in such a quarter. Inured to the Physical order of ideas they are become incapable of dealing with the Psychological. Leave them to think, if they can, that their own Meditations,

* It is exceedingly satisfactory to find that Professor Huxley, in the paper to which I shall presently refer, entirely agrees in repudiating any knowledge of efficient causes in Physics. Less accomplished men of the Professor's school are continually forgetting this truth, and setting up material causes in opposition to the spiritual first cause believed in by the Theist.

Feelings, Aspirations, are simply oxidation in Cerebral tissues of so much phosphorus. "Ephraim is joined to Idols; let him alone."

Physical Science (in fine) must not pretend to dictate to Mankind on subjects which transcend her sphere. Knowledge of the external shows of the World, beautiful and valuable as it is, can never supersede our inner experience of the life which underlies those forms. Man's knowledge of his own mental acts, derived from reflection, cannot be set aside by observation, which, pretending not to leave the region of the sensible, remains of necessity incognisant of mind. But, indeed, I do not greatly fear that common sense will ever seriously lend its ear to a Philosophy which "denying that we can know ourselves, yet insists that we can decipher the Universe."

One puzzling question remains: Wherein shall we place the mental difference between Man and those lower animals which most closely approach him in intelligence? "The range of the passions of Animals is," says Agassiz, "as extensive as that of the Human mind, and I am at a loss to perceive a difference of kind between them, however much they may differ in degree, and in the manner in which they are expressed. The gradations of the moral faculties among the higher Animals and Man are, moreover, so imperceptible, that to deny to the first a certain sense of responsibility and consciousness, would certainly be an exaggeration of the difference between Animals and Man." Again Huxley writes, "No impartial judge can doubt that the roots, as it were, of those great faculties which confer on Man his immeasurable superiority above all other animate things are traceable far down into the animate World. The Dog, the Cat, and the Parrot return love for our love, and hatred for our hatred. They are capable of shame, and of sorrow; and though they may have no logic nor conscious ratiocination, no one who has watched their ways can doubt that they possess that power of rational cerebration which evolves reasonable acts from the premises furnished by the senses, a process which takes fully as large a share as conscious reason in Human activity."

It is no subject for any one to dogmatise upon; yet, until the Naturalists show better reasons than any yet adduced, men will continue to believe that Nature, in passing upward from the Brutes, to what is, as yet, her crowning work upon this planet, has taken one of her great strides, and made a difference in kind. And a sound Psychology, guiding the careful observation of external nature, will here, I think, wholly confirm the views of common sense. As Man is apparently distiguished chiefly by his capacity for moral and spiritual ideas, it is in the faculties concerned with these that we ought to seek the special Human characteristics. It is to three great faculties, that we may trace Man's capability in this direction—Self-consciousness, Conscience, and Free Will. The first confers the idea of personality; in the second originates the sense of duty; the third carries with it the feeling of responsibility. United, these faculties confer the power of conscious self-regulation by an ideal standard of perfection. Now, what ground have we for thinking that any of the Brute Creation possess these great endowments, and share the vast responsibilities which they involve? Agassiz, in the passage I have just cited, vaguely talks of "a certain sense of responsibility and consciousness;" and I know it has been thought that, in the Dog, there is the beginning of a Conscience; the first dawning of a Moral nature. And if by Conscience be meant the dread of punishment, the Dog, no doubt, possesses one; and not the Dog alone, but many other Animals. But, if the term be used in its true sense to indicate perception of the difference in moral worth of several competing principles of action, there is then no reason to believe that Conscience is a faculty possessed by any of the lower creatures. Such of their actions as present, at first sight, the aspect of true voluntary self-restraint, are all to be

referred, I think, to training, the habit of Obedience, or to the absorbing power of some strong affection which, for the time blindly predominates. In no case that I have ever heard of need it be supposed, that there has been that conscious and voluntary preference of the higher to the lower ground of action in which the Moral life of Man consists. The moral faculty declaring "What I ought to do?" cannot conceivably exist apart from that self-consciousness which, holding up a mental mirror wherein the Soul can see and know itself, enables me to say,—"This is I."

I know what moral grandeur some of the recorded actions of Animals assume. But there is some illusion in our admiration of these affectionate and faithful Brutes. Outwardly, their acts have all the beauty of self-forgetful love. Yet how can there be self-oblivion, or self-surrender in creatures upon whom the idea of self has never dawned? Man is apt to measure all things by the standard of his own nature, and thus it is that we unconsciously attribute to the lower creatures an ideal elevation of which there is no valid reason to suppose them capable.

The supposition that the Brutes are destitute of self-consciousness, also best explains, I think, the difference between their intelligence and ours. The mind, which is a mere theatre on which impressions and recollections make their entrances and exits without the faculty of detaining or recalling them at will to compare and classify, must be incapable of general ideas, and of all abstract reasoning. To Man alone, it seems, is given command over his own intelligence. The Dog *thinks*, but only Man has *the power of thought.*

That God has withheld self-consciousness from the Brute creation, may perhaps be thought to cast some ray of light upon another mysterious subject. It may be that the gift of Immortality has, by the All-Righteous One been confined to that created being in whom alone, so far as our knowledge goes, He has raised the hope and expectation of it—who alone "thinks he is not made to die." Yet on this dark subject it becomes all to speak with great reserve. Who shall pretend even in thought, to limit His designs? Surely we may preserve our faith in Man's great heritage, without pretending to make it clear that all God's other creatures are shut out. Their destiny is nowise our concern. It is a mystery which as yet transcends our knowledge; and, not improbably, our faculty of knowledge.

In what I have just assayed to express respecting the mental characteristic of humanity, I cannot hope to content any one who denies the existence in Man of a moral faculty and free causal power. I expect no one to concur who, in metaphysics, prefers Hume and Mill to Coleridge and Martineau; or who, in Ethics, holds with Paley against Bishop Butler. The differentiation of Mankind from Brutes, must needs fail in the hands of a Philosophy which has analysed away every Human characteristic. As little can I carry with me any of the modern scientific school, which, in terms, abjures materialism, and, with Hume and Comte, disclaims knowledge of efficient causes, yet is ever seeking to refer the whole Creation, the Human mind included, to a supposed primal material impulse. No one who, like Professor Huxley, can think of his own mind as "the expression of molecular changes," in that matter of life which is common to himself and the stinging nettle, can be convinced by any argument which I have here adduced. Exiling from the world, as they seek to do, all present creative energy, such thinkers are bound to find, in every phenomenon of the Cosmos, neither more nor less than is contained in its immediate antecedent. With them, all existences are but phases of one blind force, whose undulations fill all space and time; and no essential difference can be admitted to exist amongst them.*

* This whole paragraph, with some of what precedes, has been written since the delivery of the lecture, since which, also, I have read Professor Huxley's paper in the

After all, look at it steadily, and you will see that this doctrine of Man's actual physical affinity to brutal forms, instead of raising new doubts, goes far to explain certain admitted facts of human experience, and to lesson the pressure of some old difficulties. I extract the following striking passage, (cited by Lyell, in this connection,) from *Hallam's Literature of Europe.*—"It might be wandering from the subject of these volumes if we were to pause, even shortly, to inquire whether, while the creation of a world so full of evil must ever remain the most inscrutable of mysteries, we might not be led some way in tracing the connection of moral and physical evil in man with his place in that creation; and especially, whether the law of continuity, which it has not pleased his Maker to break with respect to his bodily structure, and which binds that, in the unity of one great type, to the lower forms of animal life by the common conditions of nourishment, reproduction, and self-defence, has not rendered necessary both the physical appetites and the propensities which terminate in self; whether, again, the superior endowments of his intellectual nature, his susceptibility of moral emotion, and of those disinterested affections, which, if not exclusively, he far more intensely professes than any inferior being—above all, the gifts of conscience, and a capacity to know God, might not be expected, even beforehand, by their conflict with animal passions, to produce some partial inconsistencies, some anomalies at least, which he could not himself explain in so compound a being. Every link in the long chain of creation does not pass by easy transition into the next. There are necessary chasms, and as it were leaps from one creation to another, which, though not exceptions to the law of continuity, are accommodations of it to a new series of being. If Man was made in the image of God, he was also made in the image of an Ape. The framework of the body of him who has weighed the stars and made the lightning his slave, approaches to that of a speechless Brute, who wanders in the forests of Sumatra. Thus standing on the frontier land between animal and angelic natures, what wonder that he should partake of both!"

The same thought appears in the exhortation of the most modern-minded of Poets—

"Move upward, working out the Beast,
And let the Ape and Tiger die."

Let man put down within himself the ferocious and the obscene. The very emotion of disgust raised by our nearest neighbours on the scale, those "blurred copies" of ourselves, is not, we may be sure, without a salutary purpose in the divine economy.

Physiology, in fine, does but bring home, in a more lively way, if that be possible, one of the very oldest of human convictions, one of the very first of religious lessons. Man has always perceived within himself the contest of the double nature; has always felt the downward drag of the heavy body, the stirring of the brute within him. Oriental thought does but exaggerate this truth in the doctrine of the inherent evil of matter; a doctrine well known to

Fortnightly Review, February, 1869, "ON THE PHYSICAL BASIS OF LIFE." The physical observations detailed are of great interest. The metaphysics derived from J. S. Mill are a good example of that modern philosophizing which A. de Morgan not long ago described, with equal truth and point, as "proving that everything is something else; and nothing, anything at all." As to the Professor's humorous caution against "lunar politics," and concluding moral, it is impossible not to be reminded of the *jeu d' esprit* in *Punch*,—"What is matter? Never mind! What is mind? No matter!" It is certain that physical science cannot but lose by this alliance with mistaken metaphysics. Let the attempt be made by all means, to reduce phenomena to a common formula. But this must not be done by leaving out what is peculiar to each. It is no true science which would explain away whatever it cannot explain. Let physical philosophy confess that the phenomena of mind are wholly different from those with which it has to do.

Theology as Manicheism, to which Dean Milman traces most of the heresies of Christendom; and which may perhaps be found a large ingredient in not a few of its existing creeds. Nor is that a strange voice which we may hear complaining—"I delight in the law of God after the inner man; but I see another law in my members, warring against the law of my mind, and bringing me into captivity to the law of sin which is in my members. O wretched man that I am! who will deliver me from the body of this Death?" Cleared from the partial misconceptions which obscure it, the primitive belief in God and Man, so deeply grounded, so universally diffused, most surely will outlast successive theories of Physics which, to our darkened understandings, appear from age to age to threaten its extinction; and out of their materials will find fresh arguments to vindicate itself. And, stationed at the summit of terrestrial Nature, looking thence, backward, on the long gradations of inferior creatures, forward, up the world's great altar-stairs, to glory upon glory, dimly discerned, yet surely awaiting the obedient, the soul of Man, as in the days of old, will overflow in grateful benediction for the life already given; in earnest prayer for larger measures of the quickening Spirit Who is Himself the substance of the fuller life to come.

The Modern Aspect of Natural Theology. By C. W. Richmond, One of the Judges of the Supreme Court of New Zealand.

[*Lecture delivered in Nelson, August* 21, 1869.]

Natural Theology is definable as that branch of Moral Science which investigates the indications in Nature of the Divine existence and attributes. Observe, I say, a branch of *Moral* Science; for to me it seems a great mistake to claim a place in Physics, or even an influence, for any department of Divinity. Physical Science and Theology alike suffer from confusion of their respective Provinces. In times not very distant, Theology, as we all know, attempted to dictate to the leaders of physical inquiry, most happily for us, without success. For if the ecclesiastics could have had their way, not only should we have lost the grand results of our present extended knowledge of the laws of Nature, but Divinity itself would, in all likelihood, have retained its narrow mediæval type; and mankind, subjected to that withering influence, would have sunk deeper and deeper in the slough of a childish and cruel superstition. About 250 years ago it was heretical to believe that the earth moves round the sun. At the same period the few who had sufficient courage and enlightenment to deny the reality of witches and sorcerers were branded as blasphemers. And, reverting to still earlier times, the Australasian colonist is amused to learn, that by the Christian Father Lactantius, the Antipodes were held to be impossible; by Saint Augustine, contrary to Scripture; by Saint Boniface, of Mentz, beyond the latitude of salvation. In the middle of the eighth century, Virgilius, an Irishman, rashly venturing to assert their existence, the whole religious world was thrown, says Mr. Lecky, into a paroxism of indignation. For, as Cosmas had well reasoned, does not Saint Paul expressly tell us, that all men are made to dwell upon "the face of the earth?" From which it clearly follows that they do not live upon more faces than one, or upon the back. With such a passage before his eyes, a Christian,

says Cosmas, should not "even speak of the Antipodes." But why travel to remote ages and barbarous times for examples of these ludicrous attempts to control the course of scientific thought? We ourselves are witnesses that the same spirit has survived to our own days, and is yet active in the midst of us. We have seen, and still see, the conclusions of the Naturalist contested, not on the ground that they are unwarranted by observation, but because to the objector they seem to contradict some supposed Revelation on the subject contained in Scripture. Now I desire to assert on the threshold of our inquiry that, in regard to the constitution of the physical world, Theology must be content to sit at the feet of her younger sister Science. Scientific inference is to be supported and opposed purely on scientific grounds. But more especially in the department of Natural Theology it is obvious we must take our facts from Natural Science; making of them what we can.

But, as physical science is progressive, the illustrations drawn from nature of the theistic arguments must needs adapt themselves to this advance, and theory after theory be shown to be consistent with what is fundamental in human faith. I cannot therefore see that Dr. Hooker was justified in one charge which he made last year against this department of Theology. In his opening address, as President for the year, to the British Association, he makes it a reproach, that Natural Theology "shifts its ground to meet the requirements of every new fact that science establishes." Now in one sense, no doubt, it does, and ought, to "shift its ground." Essentially it is occupied in showing that each new fact, and each successive theory, consists with, though it may not prove, the fundamental point of Natural Religion. Its assumption of scientific conclusions is of necessity, provisional only; for these conclusions, in their very nature, are never final. Science it is rightly said, knows nothing of Confessions, Creeds, and Articles. With her nothing is permanent, except the guiding principles of her research. At each step upward a wider prospect opens out upon her; and the theories of the past expand into more comprehensive views of truth. Theology is bound to follow with her comment this continuous advance. Plainly, there is confusion in Dr. Hooker's mind between Natural Theology and those ill-judged efforts, of which we have seen so many to reconcile the facts of Science with the letter of Scripture by perverting the interpretation of both the subjects of comparison.

The earliest speculations upon the physical forces of the Universe seem to have arisen out of religious feeling—thereby understanding simply, the human sense of dependence on an irresistible external power. The might of the elements, contrasted with the sense of feebleness within, attracts an awe-struck worship; giving rise to those naturalistic systems of Religion which we find to have prevailed in the ancient civilized communities of Asia. In these systems every operation of nature is attributed to a supernatural influence. The elementary powers, and the more striking phenomena of the physical world, are impersonated and deified. In the earliest known form of the religion of India, fire, the winds, the sun, the dawn, the bright and cloudless firmament, are venerated as gods. But as there arises some conception of natural law, the notion of Divine interference becomes more and more restricted to the less frequent and apparently irregular phenomena; more especially to such as are of an appalling or destructive character. Pestilence, drought, earthquakes, hurricanes, are regarded as Divine visitations, long after men have ceased to worship the sun and stars. Eclipses, comets, and meteors, also, from their apparently irregular occurrence, and startling effect upon the senses, are placed in the same class, and taken for portents of the Divine anger. But in the progress of the adventurous European races, the bold and lively sons of Japhet have more and more asserted man's mental rights and bodily powers against external nature. Growing familiar with the regularity of all her ways, and

taught to turn to use some of her most tremendous agencies, the western nations, little by little, have ceased to yield her a divine regard. At last, nothing in nature excites a sacred awe but those unusual effects in which the hand of God is still, for the time, thought to be specially at work.

Modern science has completed this great revolution of feeling and opinion. Certainly, at the present day, no educated person supposes the Divine influence to be more peculiarly manifested in an eclipse—of which he will find the time of occurrence, and area of visibility, predicted in his Almanac with perfect accuracy—than in the phases of the moon, or the regular recurrence of the seasons. If the periodical return of comets is as yet less exactly calculated, this is only, as we all understand, because the elements of the problem are more complex; and no one doubts that, sooner or later, our present comparative ignorance will be removed. The advance of Meteorology is gradually unfolding to us the laws obeyed by the seemingly capricious winds and clouds; enabling us to plot out beforehand the destructive path of the cyclone; making it impossible to regard seasons of excessive rain or drought as the chastisement of special sins. Plague, typhus, and cholera, may, indeed, be looked on as penalties affixed, by an immutable law, to filth and laziness; but in the mediæval sense, can no longer be taken as specially expressive of God's dissatisfaction with human deeds. And the laws of nature are found to be as universal in Space as invariable in Time. The order which reigns amongst the minute particles disclosed to us by the microscope, extends to the remotest regions accessible to the powers of those huge instruments which aid the research of the modern Astronomer. The same law that brings a feather to the ground, and wheels the planets in their orbits, governs, it seems, the vast revolutions of the multiple systems of stars; white, red, green, and blue suns, circling about their several common centres, at inconceivable distances, distances compared with which the whole diameter of the Earth's orbit is but as a point. Nor is the substance of the remotest bodies different, as it appears, from those forms of matter with which we are familiar. The latest experiments on the light emitted by what are called the fixed stars, are believed to give positive assurance that the chemical constituents of these bodies are in part, at least, identical with those of our own planet. Thus, while the Divine power seems everywhere replaced by Natural force, the scrutiny of Science leaves in the wide Universe no befitting seat of Deity. What has become of the conception of a local Heaven? What place have the astronomers left for it? Herschel has tried to gauge for us the visible Universe in vain; his plummet lowered into an ocean, every drop of which is a solar system, finds no bottom. The faint and hazy light, dimmed by immeasurable distance, of suns and systems, sown in countless multitudes on the dark background, still keeps dawning on the increasing powers of our space-penetrating instruments; and beyond these visible forms of matter, if indeed they have an end, there is nothing but a sense of vacuity more appalling still. Let any one, on a starry night, look steadfastly into the starless spaces of our antarctic heavens, and let him try to fancy God's unclouded presence as shining out beyond the verge of what is visible: he will feel that Heaven can no longer seem to us, as to the early world: we cannot say of it "Lo here! Lo there!" that awful depth seems rather the abode of Eternal Night. In presence of considerations such as these, almost overwhelming as they may be found at times, even by the steadiest intellect and the most lively faith, is it surprising that, to very many, Matter and its Laws, seem all in all; or can we wonder, that the speculative mind, descending to the lowest level, sometimes finds at last a dull repose in the Dead Sea of Thought, the creed of the Materialistic atheist? This then, is the great cycle of opinion, we find the station of the bold and self-sufficient unbeliever of our days diametrically opposed to that of the submissive Asiatic—Nature,

in the old mode of thought, appearing all miraculous, wholly divine; but, in the modern view, just the reverse; quite unmiraculous and undivine.

But not materialists alone hold the opinion, that where physical law is present, God is absent. A considerable section of the "religious world," unconsciously adopts that proposition. And this explains the jealousy so frequently displayed, of all extensions of scientific knowledge. The so-called "explanations" of Science seem, from this point of view, to empty Nature of everything divine. The awful voice no longer sounds in the reverberations of the thunder: His dread judgments are no more announced in pestilence and famine: the earth no longer trembles at His look: it is not at His touch that the volcano vomits forth its smoke and lava-torrents. With these believers, as with the scientific Atheist, miracle stands as the opposite of natural law; the one divine, the other godless. With either party, to shut out miracle is to banish Deity itself. Hence the passionate opposition, renewed at every fresh attempt, made by contemporary science, at deeper penetration into the mysteries of Nature—passion arising from the unconscious notion that Faith itself depends on the continuance of scientific ignorance.

The latest instance of this state of feeling is found in the attitude taken by many theologians towards Mr. Darwin's speculations on the Origin of Species in the Organic world. So long as Creation can be regarded as a unique act, hidden deep in the past from scientific scrutiny, it may retain the character of miracle. The new doctrine of development threatens this last stronghold. In the theological view the long train of organic nature, first herb and tree, then moving creature that the waters brought forth, winged fowl, creeping thing and beast of the earth, lastly man himself, emerge at the Divine fiat from nothingness; each differing from each, fixed in its type, perfect in its kind. On the other hand the school of Darwin is striving to refer this mystery to the operation of the known laws of Organic nature. Instead of detached creative acts manifesting the power and intelligence of the Supreme, they see quasi-mechanical evolution from some primitive germ—evolution proceeding as surely, whilst I speak, as at any former instant in the world's life.

Those who have seized the principle, which in a former lecture I have endeavoured to expound and recommend, may view the controversy without taking either side, and with quiet certainty that the result must be indifferent to Natural Religion. Once perceive that Physical science can investigate only the *method* of the Universe, and except in concert with higher modes of thought, is incompetent to reveal *its cause*, and it will be plain, that Theism, at least, must stand secure in every change of scientific theory. Science, alone, does not, it must be granted, and cannot, reveal God; but far less can she provide a substitute. The whole question of causation lies beyond her sphere. This I repeat is, on all hands, an admitted principle. Bear with me whilst I endeavour to bring before you some proof of this assertion. And first as to the doctrine of the school of Hume on this important topic. "When," writes the great master in that beautifully lucid style of his, "we look about us towards external objects, and consider the operation of causes, we are never able, in a single instance, to discover any power or necessary connection; any quality, which binds the effect to the cause, and renders the one an infallible consequence of the other. We only find, that the one does actually, in fact, follow the other. The impulse of the one billiard-ball is attended with motion in the second. This is the whole that appears to the outward senses. The mind feels no sentiment or inward impression from this succession of objects: consequently there is not in any single particular instance of cause and effect anything which can suggest the idea of power or necessary connection. * *" "In reality," he continues, "there is no part of matter that does ever, by its

sensible qualities, discover any power or energy, or give us ground to imagine that it could produce anything, or be followed by any other object which we could denominate its effect. * * * The scenes of the universe are continually shifting, and one object follows another in an uninterrupted succession; as the power, or force, which actuates the whole machine, is entirely concealed from us, and never discovers itself in any of the sensible qualities of body. We know that, in fact, heat is a constant attendant of flame; but what is the connection betwixt them we have no room so much as to conjecture or imagine. It is impossible, therefore, that the idea of power can be derived from the contemplation of bodies in single instances of their operation, because no bodies ever discover any power which can be the original of this idea." With equal emphasis, John Stuart Mill declares, that scientific investigation is not concerned with the inquiry into the efficient cause of a phenomenon, "the cause which is not only *followed by*, but actually *produces*, the effect." Some writers, thinking they are following Mill, are ready to assert that juxta-position of certain elements *produces* the galvanic current; or even, that like juxta-position *produces* mental action. Their master is more consistent in his Nescience. Strange as it may seem, with him, as with the great originator of this way of thinking, no one thing, within our knowledge, produces any other. Certain things invariably *follow* other things: Hume, Mill, Comte, pretend to know no more. The leaders entering the penetralia of Nature's temple, report they find a vacant seat, an empty shrine; *(vacuam sedem, inania arcana)*; the weaker followers declare they see the idol of Material Necessity enthroned between the Cherubim.*

I now turn to the teaching of the opposite school. This need not long detain us; for nothing is more certain than that thinkers of this class give not the slightest countenance to the fallacy that the so-called powers of Nature can, in themselves be causative.

These metaphysicians, jealous as they are of the rights of common sense, and strong in their belief that every instructive assurance of our nature points at some reality, yet join with Hume and Mill to set aside that mistaken notion which I am combating. "Rude nations," says Dr. Reid, "do really believe

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* With those disciples of Mill who, like a Reviewer of my former Lecture, "attribute nothing to matter as a cause," I have, so far, no difference; except that it seems to me they are not justified in adopting such a formula as "that mental phenomena are *the result* of cerebral organisation," without a distinct understanding that the word "result" carries with it no sense of necessary connection. This is their difficulty. For they themselves, in spite of their philosophy, like all mankind, cannot help letting the true idea of cause (disowned by Hume) glide in. Thus, unwittingly, and unwillingly, they are materialists. "Result" will continue, in spite of every philosophic caution to be taken as equivalent to "effect." "Effect" imports its correlative "cause." If we wish to understand one another, we must banish words in which there lurks a casual signification, and keep to terms such as "consequent" and "concomitant." My reviewer himself betrays the weakness I have pointed out, and forgets the doctrine of his school, when he talks of Nature "manipulating cerebral matter so as to *produce* mental phenomena." What is this (to use his own language) but to make a supposed "metaphysical entity 'Nature' 'do duty as an efficient cause." Nor is this in his mouth, a mere rhetorical expression, such as he himself lays hold of in his remarks on the passage cited by me from Martineau's Sermons. It betrays the inner conception of Natural (or Material) Necessity, as the first cause of things. So in the poem of the great Latin Materialist, *Natura, Venus, dædala tellus*, are assumed as causes. Further on in the argument I am pursuing in the text, I come upon the fundamental difference between the two Philosophies. Hume, and his sect, in ignoring causation (except, as an eviscerated notion, in the sense of invariable sequence) contradict our consciousness of that moral freedom, and avow their nescience of God: thus sapping *the intellectual* basis of both Morals and Religion. By regarding Matter "merely as a condition of phenomena," like Time and Space, this mode of thought escapes the grossness of common Materialism becoming intensely Idealistic; but the restriction of knowledge to *phenomena* leaves Man a phantom in the world of phantoms.

sun, moon and stars, earth, sea and air, fountains and lakes, to have understanding and active power. * * * As philosophy advances, life and activity in natural objects retires, and leaves them dead and inactive. Instead of moving voluntarily, we find them to be moved necessarily; instead of acting, we find them to be acted upon; and Nature appears to us one great machine, where one wheel is turned by another, that by a third; and how far this necessary succession may reach the Philosopher does not know."

But it will be asked, are not the various Forces which Modern Science has detected, truly efficient causes; which the Theist, if he please, may style *second causes*, but which the scientific mind may rest upon as ultimate? Are not Gravitation, Elasticity, Cohesion, Attraction, Electricity, Magnetism, Caloric, Chemical Affinity, and the rest, causes in this sense? To these questions Hume and the Positivist school, with Mill and all his followers, will still answer with an avowal of ignorance. For their philosophy knows nothing but phenomena. Force, clearly, is no phenomenon, but the hidden producer of phenomena. And in this answer the opposite sect in metaphysics will most certainly concur. As Martineau shortly puts it, "Inductive Science gives us no access to causes behind phenomena." Force is not matter, but the supposed power which acts on matter. In itself it is invisible, inaudible, impalpable, inaccessible, in short, to sense of any kind, or to any instruments of sense. Its intensity, indeed, as appearing in its various effects of motion, weight, elasticity, colour, heat, deflection of the needle, and so on, is, in most cases measurable by appropriate methods. But the power itself lies outside the field of observation; like that veiled Egyptian goddess, whose hands, stretched forth from her closely enwrapping mantle, alone were visible. "You sometimes speak of gravity," Sir Isaac Newton writes to Bentley, "as essential and inherent to matter. Pray do not ascribe that notion to me; for the cause of gravity is what I do not pretend to know." Here we have the great discoverer avowing, that gravitation, according to his judgment, is not in itself a cause but the effect of some ulterior and undiscovered agency. If this be the case with gravity, it will scarcely be denied that the same is true of the entire catalogue of forces I have above rehearsed, together with actinic force, kinetic, and whatever other fresh coinage the always-active mind of scientific terminology may hereafter issue for temporary circulation. All are but names, I will not say to cover ignorance, although, in fact, they do conceal it, but to indicate the supposed common origin of phenomena which appear connected.

This will be made still plainer if we observe two contrary tendencies of physical research. On the one hand, there is a tendency to augment the number of supposed material forces arising from the continual discovery of natural operations before unobserved. When such discovery occurs; as in the case of the action of light on certain salts of silver, (now become to us so familiar a fact in the arts of Photography;) the new class of effects is ascribed, for a time, to a new species of natural power. Thus Photography has taught us to speak of the "actinic" power of light. But on the other hand investigation is ever revealing to us the hidden analogies of Nature, and thus enabling us to collect phenomena in larger groups, which we then refer to some one form of force, instead of, as before, to several different forces. Here there is a tendency to reduce the length of the Dynamic catalogue. This consideration should satisfy us that the (so-called) physical agencies are plastic suppositions; hypotheses to serve a temporary purpose in scientific classification; not existences of which we have any real knowledge. Moreover the tendency of Modern Science is wholly to abandon the former notion of a multitude of Forces, and to refer all natural operations to a single form of Force. Force according to modern theory, never disappears in one shape without reappearing in another, with exactly corresponding intensity. The blow of the smith's

hammer is arrested by the anvil, and its force seems spent; but, in truth, it only changes shape, reappearing in the form of heat communicated to the anvil and the hammer. In the steam engine we see the reverse operation—Heat, in this instance, disappears in producing mechanical force. In like manner Heat will produce thermo-electric currents, whilst Electricity, in its turn, generates Heat. Electricity and Magnetism also, it is now known, are mutually convertible. Temporary magnets are made by electric currents, and sparks are elicited from magnets. Many other instances of like convertibility might be given. It is likely, then, that our conception of natural forces will, sooner or later, be reduced to some single type; and this one force will be conceived of as ever varying in its aspects; now Heat, now Chemical force, and now Mechanical; yet never spent. Here, then, it will perhaps be said, we shall have at last the material cause of which we are in search. I answer, No; you will have found matter in action; nothing more. The question will remain unanswered, "what makes it act?"

The Theist may then leave Darwinians to fight it out with their opponents on the scientific field; secure that Natural Religion is nowise interested in the issue of the controversy. But is human faith, in any shape, truly in peril should it be established, as seems not unlikely, that Creation is no past event but a process ever going on? Grant to the advocate of progressive Development his "nucleated vesicle," "primordial cell," or whatever he likes to call it, out of which he is to bring the whole Organic world. Only do you and he remember, that the whole animal and vegetable kingdoms are in that cell, as truly as the oak is in the acorn. The cell accounts, he says, for the whole Organic world. Be it so: but the cell? what accounts for that?

And, as we further see, the ground of the religious opposition is a misconception. The antithesis of miracle and natural law, as one divine, the other undivine, is, here, a false one; for the Power of God is no more at work in miracle than in Nature.

Observe, I speak of the operation of Divine power, not of the manifestation of Divine purpose, which is not here in question. In almost every form of creed, the Divine character is supposed to be more fully expressed in miracle than in Nature. But of Divine power, surely, this amazing universe, filled and pulsating with self-renewing life in countless myriads of forms, is the greater physical expression: so that it is absurd to compare with it, in this respect, any recorded or imaginable deviation from established order. "Command that these stones be made bread," was the word of the Tempter, as we read. The miracle, though then withheld, is worked, (on how huge a scale!) in each returning season, in our ripened crops. To fill a starving multitude from the scanty store of a poor fisher, what indeed, as a work of power is that to Him,

> "Who men and angels daily feeds,
> And stills the wailing sea-bird, on the hungry shore?"

Scattered miracles of healing are small things to the repairing power of nature, or to that "stupendous alchemy" ever at work transmitting inorganic matter into living tissues. Nay, as a physical wonder, what is resuscitation of a single life, whilst in the birth of Human infants (to speak only of this Planet) the new creation of living souls takes place by thousands every hour?

But to resume our former argument. Science can never touch the ground of Theism; for it knows nothing of efficient causes. The mind ranges in vain through nature for any original source of power. We find, as Reid puts it, wheel turned by wheel in endless succession, but never reach the origin of motion. For Matter (whatever it may be) we must needs conceive of as inert; that is its very definition; and of Force, in its essence, science must remain for ever ignorant.

It is beside my present purpose greatly to enlarge on the mental process by which the philosophic Theist supplies the blank thus left by science. Beyond the point we have now reached, the great contending sects of metaphysical thinkers have no common ground. I can no longer vouch the authority of the great Scottish sceptic and his followers, nor avoid collision with the Positivist sect. Yet I do not assent to the suggestion that the attempt to handle these great subjects, on intellectual grounds, yet, in a popular way, is an unwise one, merely because philosophers are not agreed about them. They are people's questions, for they concern the springs of human action in daily life, and must be settled by appeal to the broad experience of our common nature. There are some subjects on which men whose walk is in the beaten tracks of life—who have experienced the ordinary lot—acting, suffering, feeling, thinking, in the way of all mankind; may have a surer vision of the truth than is accorded to the calm and pure, yet frigid, formal, unimaginative intellect of the closeted Philosopher. Be it far from me to pass a moral judgment on these exceptional natures; or to conclude that their lives must be vicious and unholy, because I deem their principles unsound! Judging men by their actions, it will appear, plainly enough, that some have found a way to reconcile what seems a barren and repulsive creed of mere negations with a life of strenuous effort and noble aspiration. Such have become, and are an illustration to their country, and an honour to mankind. Let it be left to the great Taskmaster to judge His servants. To him they stand or fall.

One word to some to whom the argument may be distasteful on another ground. Faith, I concede, has her experiments as well as Science; and they are happy, who by wholly other ways than those which we are trying, may have "felt after" and found Him who is "not far from every one of us." To some such, I anticipate, discussion like the present may seem superfluous, or worse. The Supreme certainty will appear to them too true and real for elaborate proof, if not too sacred for metaphysical discussion. Yet let me urge, that all men are not in this happy case. The intellect has its demands; demands which, at the present time, it is unwise, unsafe, and wrong, to overlook. The reassuring faculty, "sounding on its dim and perilous way," can never, I am well convinced, beget assurance on this great subject; but it may remove impediments which are stumbling blocks to many; it may confirm conclusions based on surer ground; above all, it may rouse men from that mental torpor which is a disease far commoner than positive unbelief.

Eschewing, so far as I am able, the refinements of metaphysical discussion, I shall, then, briefly state the grounds on which my own intellect arrives at its conclusion. I accept, as satisfactory, the doctrine that we derive the idea of "Force" from our own experience of the action of the "Will." In volition, we have, I think, the sense of intellectual effort; of force put out, and resistance overcome; of strain kept up in spite of weariness. Having conceived a mental purpose we are conscious of putting forth a power whereby the thing conceived of may be effected. I speak here of purely mental experiences; and in this sphere, it seems to me, I say, that our wills appear to us to be efficient causes.* "Force," then, in our experience, is as Dr. Carpenter has put it,—"the direct expression, or manifestation, of that mental

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* As regards our bodily motions, it may be granted to Hume, Brown, and J. S. Mill, that our will really causes them "in the same sense," (to quote the last-named writer) "and in no other, in which cold causes ice, or a spark causes an explosion of gunpowder. The volition, a state of our mind, is the antecedent; [*not cause*;] the motion of our limbs, in conformity to the volition, is the consequent; [*not effect.*]" This much, I say, may be granted as to the *connection* of the two events, viz., the volition and ensuing bodily movement. Our sense of power is *in the volition itself* apart from any physical result.

state which we call Will." It is the name we give to our own self-conscious exercise of power. We know, and can conceive of, no other form of Force. Constrained by a law of our nature, (that law which, uncorrected by our higher reason, suggests to us the notion of physical causation); to refer every phenomenon to a cause, we can do no otherwise than suppose, in the background of Nature, a power producing her appearances. This power we must needs conceive of as cognate with the only form of power of which we have experience. Thus it comes to pass, that the unsophisticated intellect must see in Nature the expression of a Mind; and suppose beneath the veil of fleeting phenomena the enduring force of a living Will. *Force* is but the metaphysical idea of *Will* transferred to the field of physics. *Force is will supposed in action upon matter.* The conception is the indispensable sub-stratum of all physical speculation; yet the origin of the idea, as of those of *Substance*, Space, and Time, is hyper-physical. I do not say that there is *logical* ground for the belief that all phenomena must bear the same kind of efficient cause with one type of Force which our narrow human experience makes known to us; or even for the belief that all phenomena must have a cause. These beliefs lie deeper than logic. They are laws of that mental constitution on which Logic itself depends.

How mind can act on Matter must remain to us an impenetrable mystery. But, when called upon to choose between Mind and Matter for the origin and motive power of the universe, we can be at no loss; for Matter we must think of as inert; Mind, on the other hand, we are conscious of as active. When, however, we attempt to realize to ourselves the mode of the Divine action in the Universe of matter, we at once encounter a great difficulty of conception. Are we to suppose a distinct volition for every phenomenon; and to call in the Divine power to produce a spark, or form a rain-drop? We shrink from the idea as irreverent, if not impossible. On the other hand, suppose His volitions quarrel, and Himself, in Nature, regardless of particulars, and what becomes of that Providence without which not a sparrow falls, and by which the very hairs of our head are numbered? Nor can we escape the difficulty by the denial of God's immanency in Nature. It is idle to interpose between Him and His universe the machinery of secondary causes. We have seen the fallacy of imputing power to the temporary fictions of scientific generalization, as if gravitation, or electricity, were capable of being regarded as real agents. Driven from our refuge in the sophistry of so-called material causation, nothing is left but the world of spirit. In former ages there was no difficulty in the conception of intermedial agencies of a spiritual kind. In the Talmud a special angel is assigned to every star, and to every element. But the day for such fancies is gone by. In my judgment one difficulty is irremovable; for it arises from the natural limitation of our faculties. *We* view all things as existing in space or time. We know not that such is the mode of the Almighty's thought. Nay, rather, we believe that, to the great I AM, Past and Future are merged in an eternal Present: that to Him there is, physically, neither great nor small: neither far nor near: that, in the infinite sphere of His Providence the centre is everywhere. But though our faith be that He reconciles the claims of General and Particular in his boundless universe; and, whilst maintaining the grand and beautiful uniformities of Cosmical law, that His tender mercies are over all His works, we needs must own, that to comprehend, or even to imagine, *how* this can be, transcends our feeble faculties.

The way is now open for us to consider more precisely the modern aspect of Physical Science, in its organic branches. This has appeared to many leading scientific minds highly unfavourable to those arguments from particular

Design, on what the theologians of the last century were wont to lay the greatest stress. As we have just seen, there are two ways in which the human mind strives to represent to itself the divine activity in the universe of matter. According to the one mode of thought, *the general plan of Creation* is paramount; according to the other, *the particular creatures.* Corresponding with this division is the difference between the past and present aspects of Organic science. The naturalist of last century separately examined each particular species of the Animal Kingdom, with reference to its external form, and mode of life. Great stress was laid in classification upon such characters, as the nature of food; whether it were a carnivorous, herbivorous, or insectivorous creature: or the habitat whether terrestrial, aerial, or aquatic; or the mode of progression, whether on hoofs, by wings, by fins or otherwise; in short, upon which it seemed fitted to attain.

This method of classification is known as *Teleological*, or purposive, (from "telos" an end, a purpose) being based on the apparent *purpose* of an organism rather than on its structure, or course of development. But there are radical objections to this method of arrangement. "It is frequently found that two organs which are not unlike in external form, and which have corresponding functions in the system, originate from elements entirely different, and are therefore fundamentally dissimilar; while, and on the other hand, organs which at first sight present little or no resemblance to each other, and are applied to very different purposes in the economy, may be really modifications of the same fundamental component."—Carp. § 4.

The wings of Insects, as compared with those of Birds, are a good instance of the identity of function combined with fundamental diversity of structure. In structure the wings of Insects really are analogous, or, as the phrase now is, *homologous*, with certain structures, which in other articulated animals constitute part of the breathing apparatus. Hence Oken calls the wings of Insects "*aerial gills.*" The attempt to bring into comparison the wings of insects with those of birds and bats can now, as Carpenter observes, only excite a smile on the part of the philosophical anatomist. Again, the gills of fishes correspond in function with the lungs of air-breathing vertebrates. But, in structure, lungs are the homologues, not of the gills, but of the air-bladder in Fishes; an organ which has no respiratory function. Modern classification no longer proceeds, therefore, upon *analogy*, that is resemblance *of function*, but upon *homology*, that is identity, *of structural type*. With the modern naturalist, the question is, not, what life the animal was meant to lead, but, what is the formal plan on which it is constructed? Proceeding thus, he finds, "that in the several tribes of organised beings, we have, not a mere aggregation of individuals, each formed upon an independent model, and presenting a type of structure peculiar to itself, but that we may trace throughout each assemblage, a conformity to a general plan which may be expressed in an 'archetype,' or ideal model.*" * * * "The typical structure of any group being given, the different habits of its component species, or minor groups, are provided for, not by the creation of new organs, or the destruction of others, but by the *modification* in form, structure, or place, of organs typically belonging to the group.† This method in natural science is known as the *Morphological* (from "morphē"), "form;" because it regards community of form or type. The obvious defects in the arrangement of the mammalia, by the illustrious Cuvier, seems attributable to his partial adherence to the teleological method. His great primary division into Unguiculata (clawed), Ungulata (hoofed), and Mutilata (wanting the posterior

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* Carpenter, "Comp. Physiol.," § 11.

† *Ibid.* § 77, (citing Bell on "British Crustacea.")

limbs) has reference rather to the adaptation of the creature to its external life than to the general plan of its structure. The division leads to a confusion which has become manifest in the light of the more advanced science of the present day. The whale tribe (Cetacea) with their high mammalian organisation, appear unduly degraded to the very bottom of Cuvier's table, merely because the wants of a purely marine habitat have been met by a development of the caudal extremity of the vertebral column, which supersedes the necessity for a development of the posterior limbs. On the other hand the Ornithorynchus (order *Monotremata*), whose structure presents marked analogies to the oviparous vertebrates, is elevated, merely in virtue of its clawed extremites, to a place above the Elephant and Horse. Yet, as Owen remarks, "no one has proposed to associate the unguiculate Bird or Lizard with the unguiculate Ape; and it is but a little less violation of natural affinities to associate the Monotrenes with the Quadrumanes in the same primary (unguiculate) division of the mammalian class." Again Cuvier's secondary division according to the structure of the teeth is open to the same objection, and leads through, in a less degree, to the same inversion of Natural order, and confusion of Natural affinity. The possession by the Kangaroo of three kinds of teeth, elevated the genus, in Cuvier's list, to a place intermediate between the Carnivora and Rodentia, removing it from its true association with that other strange Australian already mentioned, the Ornithorynchus; which as wanting canine teeth and incisors, was ranked with South American types, the Armadillo, Sloth, and Ant-eater. The superiority of the more modern method, as a ground of classification, is best made evident in the case of the rudimentary organs. These would seem to the Teleologist but as "freaks of nature;" whilst to the eye of Morphology they are characters of the utmost significance. Thus Dr. Carpenter writes:—"We find, as might have been expected, * * that if the plan of structure in a particular tribe involves the *non*-development of some organ which is possessed by neighbouring groups, its conformity to archetypal regularity is generally manifested by the presence of that organ in a *rudimentary*, or undeveloped condition. Thus, we find some rudiment of the lung in most Fishes, even where it is not sufficiently developed to serve as an 'air-bladder' in regulating the specific gravity of the body. In the abdominal muscles of Mammals, again, we find the abdominal sternum and ribs of Saurian Reptiles indicated by white fibrous bands; and in those Mammals which do not possess a clavicle, that bone is usually represented by a ligament, just as the stylo-hyoid ligaments in Man represents a portion of the hyoidean arch which is elsewhere [i.e., in others of the Mammalia] completely ossified. Such rudimentary structures, however, often display themselves only at an early period of development, and are subsequently lost sight of. Thus the rudiments of teeth, which are never developed, and which, at a later period cannot be detected, are found in the embryo of the Whale, both in the upper and under jaws; and Professor Goodsir has ascertained that the rudiments of canine teeth, and of the incisors of the upper jaw, which are not subsequently developed, exist in the embryos of Ruminating Mammals. The most remarkable example of the kind, however, is the existence of *branchial arches*, resembling those of the Fish, in the early embryo of *all* air-breathing Mammalia." In the Vegetable kingdom the same conformity to a common type is manifested by the presence of rudimentary organs. In the common *Sage*, for example, "we find only two stamens where the general plan of the flower would lead us to expect five; but upon looking attentively at the interior of the corolla, two little scales are often to be seen growing in the place where two of the deficient stamens should have been; these two scales are frequently developed as perfect stamens in flowers which are otherwise constructed precisely like the sage; and even the fifth makes its appearance in

some instances, exactly where it should be regularly found."—(Carp. *ib.*) In these and many like cases, parts which we are perhaps justified in saying are perfectly useless to the individual creature, seem to exist purely in conformity with the great law of the unity of Organic type.

To the Natural Theologian following in the track of the older school of Naturalists, rudimentary organs were as great a stumbling block as to his leaders. The scarcely perceptible eyes of the mole may deserve the special praise accorded by Paley, in this instance, to Divine "skill;" but on his view of things, what can we make of that species in which the aborted organ is completely covered from the light? What, again, of the teeth of the fœtal whale, or of the undeveloped air-bladder of some Fishes, or of the redundant provision of gills and lungs in some of the Batrachians, or of the caudal vertebræ in Man? A yet more serious difficulty beset the utilitarian Divine in this department of his work. "*Adaptation*" was a word as much in vogue with him as now is "*Correlation*" with the Darwinians. In Paley's pages one reads perpetually of the Divine "contrivances." It is obvious to ask "Wherefore all this painful adaptation of means to ends?" Why should Omnipotence resort to contrivance to attain particular purposes? As Paley himself perceives "contrivance by its very definition and nature is the refuge of imperfection." Besides, after all that can be said on the admirable structure of the Eye, and its adaptation to the light, the intervention of Almighty power still appears needful to enable us to see. How otherwise can the inverted image on the retina raise in the Mind a visual idea? How can any mechanism bridge over the chasm between the material image and the immaterial Mind? Then why should God devise complex machinery, which, after all, does not dispense with his direct volition? "What fitness," it is well demanded, "is there in one mechanism more than in another, or in any than in none at all, to produce its appended perception?"

Now in these, and kindred questions, Morphological Science comes in to relieve, though, it may be, not wholly to remove our difficulties. Discarding the mechanical idea, it calls on us to regard the Universe, not as a piece-meal product in which God, by a series of contrivances, has managed to adapt particular creations, one by one, to pre-established general laws, but as a mighty whole, whereof the parts are mutually related, and cohere in one all-comprehensive system. From this point of view, the eye seems adapted to the light, neither more nor less than the light to the eye. The great optical laws extending over tracts of time and space where vision cannot be, yet have relation to that wondrous little structure no less than it to them. The old idea of *adaptation* merges in the wider one of *correlation;* and all the forces of the Universe are seen to be cöoperant. Symmetry and Beauty, in and for themselves, appear to be creative ends which the Divine Artist has not thought fit to disregard; and we are at liberty to think that many things are as they are, not because He could not otherwise have reached some special purpose, but because he never violates that Order of thought, and Harmony of design, by which His mind expresses itselt in Matter. Nor can we fail to see that one beneficial result, at least, in relation to God's intelligent creatures has been attained by this inflexible regard to order; for had he condescended to no method in His Universe, Science itself would have been impossible. The physical world have been an undecipherable Enigma, differing from the wonderful reality as does an incoherent scrawl from an intelligible writing.

This wider view of Nature leaves unshaken in the older argument all that is really sound. The moral proof of beneficent design cannot be weakened by observing, that the fitness of every part for its peculiar function is attained without departure from the grander principle of Organic symmetry. The two ends are reached concurrently. I again cite from Dr. Carpenter the following passage:—

"We can scarcely select any example of diversity of external conformation and of function, *superinduced upon an essential unity of organisation*, so appropriate as that which is afforded by the comparison of those different modifications of the limbs or members, and especially of the anterior pair, by which the several species of Vertebrated animals are adapted to the most diversified modes of life. No Comparative Anatomist has the slightest hesitation in admitting that the pectoral fin of a Fish, the wing of a Bird, the paddle of a Dolphin, the fore-leg of a Deer, the wing of a Bat, and the arm of a Man, are the same organs; notwithstanding that their forms are so varied, the uses to which they are applied so unlike each other. For all these organs not only occupy the same position in the fabric, but are developed after the same manner; and when their osseous frame-work is examined, it is found to be composed of parts which are strictly comparable one with another, although varying in number and in relative proportion.

"Thus, commencing from the shoulder-joint, we can almost everywhere [i.e., in the anterior limbs of all the creatures just named] recognize without difficulty the *Humerus*, it being only in Fishes that this is so little developed as not to intervene between the scapula and the bones of the fore-arm; next we have the *radius* and *ulna*, whose presence is always distinguishable, although one of them may be in only a rudimentary condition; then, beneath the wrist-joint, we find the bones of the *carpus*, which are normally ten in number, forming two rows, but which may be reduced by non-development to any smaller number—three, two, or even one; next we find the *metacarpal* bones, which are normally five, but are sometimes reduced among the higher Vertebrata to four, three, two, or one; while in Fishes they may be multiplied to the number of twenty or more; and lastly we have the *digital* bones, of which there are normally five sets, each consisting of three or more phalanges, but which are subject to the same reduction or multiplication as the metacarpal. It is entirely from the differences of conformation which these osseous elements gradually come to present in the course of their development, that those special adaptations arise, which fit their combination in each case for the wants of the particular species that possesses it; enabling it to be used as an instrument for terrestrial, aquatic, or aerial progression; for swimming and diving, for walking and running, for climbing and flying, for burrowing and tearing; or for that combination of refined and varied manifestations which renders the hand of Man capable of serving as an instrument wherewith to execute the conceptions of his fertile intellect."

As further illustrations, the proboscis of the Elephant, which constitutes so wonderful an instrument of prehension, is, properly, no special organ but an extended nose; and an approach to a like extension is presented by the Tapirs among existing Mammals, as well as by various extinct animals of the same order. "So, turning to the Vegetable Kingdom, we find that [apparently] special organs, such as tendrils, pitchers, fly-traps, etc., are evolved out of the more general type of the leaf, and are not introduced as additional to the ordinary fabric."

To me, I confess, it seems unsound and dangerous to rest the proof of design upon the existence of supposed anomalies introduced into the general plan for a special purpose. Sooner or later the supposed anomaly is sure to be explained away. It is well to take warning on this head from the mistakes of the last generation. To illustrate my meaning—Paley, in reference to the compensation of certain supposed deficiencies in the organisation of the Bat, writes thus:—"These inabilities are made up to her by the contrivance in her wing, and in placing *a claw* on that part the Creator has deviated from the analogy observed in winged animals. A singular defect required a singular substitute." But, in Nature, we have learnt, by this time, nothing is singular. The Bat's supposed

"claw," "the contrivance in her wing," turns out, we see, to be *a thumb!* The supposed deviation from Universal order proves to be perfect uniformity. The narrow notion of quasi-miraculous adaptation disappears in the perception of the harmonious plan which answers every end at once. Yet, shall we say the view is false which sees in the provision for the dusky little creature a purpose as dear to God, as plain a revelation, as in that boundless plan of Nature which fills and masters the Imagination of Philosophers? Are these humble, beneficent utilities indeed beneath His scope? Surely there is a wiser way than this of looking at it. Just as, in some masterpiece of Literature, sense and sound, aiding each other, are alike complete and satisfying, and use and beauty, in perfection, are attained together; so is it in the Universe of things, though on a transcendent scale which beggars all comparison. None can say which is there supreme, Utility or Beauty; for both seem ends, and both seem perfectly achieved. They are, indeed, but different aspects of the same perfection. In the work of human art, one mind prefers to dwell on the harmony and grandeur of the language, another on the pregnant meaning of this or that particular verse or sentence. Both estimates, in their way, are just, and both inadequate. And thus it is with those diverse views of Nature which we have been considering. Some men are wholly taken up with admiration of the majestic uniformity of Natural law; others, taking a view at once humbler and higher, simpler and more devout, rather delight to trace the apparent purpose in some particular portion of God's works; but none can reach the meaning of the whole. Yet seeing, as we do, how He, in Nature, seems to combine harmoniously His general and particular purposes, are we not encouraged to believe, that in the higher region of His spiritual action, (however dark to us the method,) the like consistency obtains; and that the wide design which enchains Ages and Nations, and conducts the Education of the World, yet leaves room for special dealing, adapted to its wants, with the humblest human soul that turns towards him?

To return once more to Physics; no one can fail to see, that in putting a new face on Science, the great resource has been the study of Development. Following this path, the modern Naturalist has solved a host of questions, having reference not merely to the nature of particular organs, but to the true relation between different groups of living beings. This fruitful method was first applied in Botany. In this department the gradual metamorphosis of all the organs from a common form is most distinctly traceable in the life of individual plants; and here, accordingly, was made the earliest application of the modern principle. Goethe showed that the various parts of plants are transformations of the axis and its appendages: the axis consisting, in its upward development, of the stem and branches; in its downward development of the root: the axial appendages, in their simple form, being leaves. All organs not parts of the axis itself, whether bracts, sepals, petals, stamens, or pistils, are now known to be modified leaves. The gradational passage from leaf to bract, from bract to sepal, from sepal to petal, from petal to stamen, is traceable in various plants. The same principle of research was soon extended to the Animal Kingdom. The metamorphosis of some creatures, Insects, for example, and Tadpoles, to the forms of maturity, takes place after birth. Amongst the higher animals each creature goes through its most striking transformations before it enters on a separate existence. Embryology, therefore, is the science which has thrown most light on Animal metamorphosis. It is the astonishing revelation of this department of enquiry that every organ of every animal is evolved from a common starting point—the simple cell—by a gradual passage from that primal integer of life to forms more special and complex. Pursuing the same line of thought and observation, in reference to the bony structure of

the Vertebrata, Oken and Owen have shown the development of the entire skeleton from the vertebral axis and its appendages; thus disclosing a series of phenomena parallel with those of the Vegetable world, and demonstrating the absolute unity in this respect of archetypal plan in the highest sub-division of the Animal Kingdom.

Last of all, Darwin and his followers propose to elucidate the development of Species by the same procedure which has revealed the mysteries of individual growth. It is plain that in this attempt they are in entire accordance with the spirit and tendency of modern Science. If the Darwinians are in the right—and I know not why we should desire to see their theory refuted—not only the birth of idividuals, but the evolution of species is now proceeding as surely as at any former period; and we must henceforth speak of Creation in the present tense. It is matter of regret, though not of wonder, that the able and judicious author of so great a speculation should himself appear at times to misinterpret the theological bearing of his own ideas; writing as if his theory tended to supersede the notion of intelligent design. That this is a great error I trust I have made clear, and have succeeded in convincing you that such speculations do but open out upon us grander notions of the universal method. He whom we worship "worketh hitherto;" immanent in His universe, and active, now, as when the fiat first went forth "Let there be Light:"—

> "For was, and is, and will be, are but is;
> And all creation is one act at once
> The birth of light: but we that are not all,
> As parts, can see but parts, now this, now that,
> And live, perforce, from thought to thought and make
> One act a phantom of succession:"—

The theist, therefore, needs not fear to see these impressions of symmetry, which arise on contemplation of the laws of the Inorganic world, rapidly extending themselves to include Organic nature. The singular limitation of Paley's view, and that of his age, to special utilities and quasi-mechanical adjustments, caused him to underrate some of the sublimest testimony which Nature bears to her Maker's power and wisdom. In the stomach of a grub he could find the traces of a purpose which he vainly sought for in the solar system. To him the harmony of the spheres spoke of no musician, for of Order and Beauty as ends in themselves he was unable to conceive. Loving to view the Universe, not as a whole, but as made up of parts, "the glory of the sum of things" had never flashed upon him. For he looked on Nature with the mechanician's eye, not with the artist's; and unless he fancied he could guess an ulterior purpose her symmetry and beauty were almost wholly lost upon him. But once seize the conception that order, ratio, symmetry, beauty, do in themselves bespeak designing mind as clearly as utility itself, and Inorganic Nature will be seen to bear its testimony to the Creative Intellect as plainly as the Animated World.

It would detain us too long were I to treat in detail this branch of the subject: I must content myself with a few words. The ideas of "Space," "Time," and "Number," form the foundation of the pure sciences of Geometry, Algebra, and Arithmetic. The truths of these Sciences are *abstract* and *necessary*. They are *abstract* as having essentially no relation to the external world. No one ever consdered the line or circle, conceived of in the mathematics, as *necessary*, because, when understood, we perceive not only that they *are* true, but that they must be true. We can, by no effort, imagine that two and two make five; that two parallel straight lines when produced can meet; that the three angles of a triangle are, together, greater or less, than two right angles; neither can we conceive that these things ever were, or ever will be, here or elsewhere, otherwise than as we now conceive of them. These Sciences, then,

deal with abstract and necessary forms of Human thought. They disclose to us an infinity of ratios, or relations, subsisting between the various ideas of number and magnitude with which they deal; comprising the properties of geometrical figures, plane and solid, triangles, squares, circles, ellipses, prisms, cylinders, cones, spheres, etc. Now, on coming to the examination of external Nature, Man finds to his amazement that Nature "geometrizes" in all her departments. There is a definite apportionment of Space and Time, there are definite relations of Number and Magnitude, underlying, as it were, all Natural operations. The geometrical webs spun by man in his own brain, with ideal lines, turn out to be the ground-plans of Nature herself. The planets, to take a familiar instance, move round the sun in elliptical orbits, having the sun for a common focus. Their speed in different parts of their orbits is governed by a law capable of precise geometrical expression; for every planet moves in such a way that the line drawn from it to the sun sweeps over equal areas in equal times. An exact arithmetical relation subsists between the periods of revolution of the several planets and their respective distances from the Sun; the squares of the period being proportional to the cubes of the mean distances. Again Bode's law discloses a rather remarkable numerical harmony in the progression of the distances of the planets from the Sun.

The general regularity of this series (a series in duple progression), was early observed: but the rule seemed to be broken in the case of the wide interval between Mars and Jupiter, where a member of the system seemed wanting. Bode argued that a planet must exist to fill up this gap; and towards the close of the last century there began a search for it. This has resulted in the discovery of a whole family of comparatively minute bodies, which may have been fragments of a larger one. Collectively, at all events, these planetoids fulfil the expectation of Science, for they revolve in orbits at a mean distance from the sun almost exactly corresponding with that indicated by Bode's law, as the proper distance of the missing member of the system.*

Chemistry gives limits of the mathematical groundwork of Nature as distinct, almost, as those conveyed by the queenly science of Astronomy. The supposed primitive elements of bodies, Oxygen, Hydrogen, Nitrogen, Carbon, and the rest, in whatever quantities they are mixed, *combine* with one another only in constant numerical proportions. When, as is commonly the case, one substance combines with another in several different proportions, the higher proportions are multiples of the lowest. This gives to the formulæ of Chemistry the very aspect of an algebraic series. Even the laws of musical concord depend upon the ratio subsisting between the numbers, in a given time, of the vibrations which produce the notes. In the simple chord of three notes, or harmonic triad, the *Dominant* performs four vibrations, whilst the *Third* performs five, and the *Fifth* six; and the superior, because more readily perceived, harmony of the combination is dependent upon the simplicity of this ratio. I believe there is little doubt that harmony of colour depends on a similar

* Even more striking than these instances, is the fact, that the law of gravity itself may be regarded as the simple expression of an *à priori* truth dependent upon the abstract conception of Force, and on the geometrical relation subsisting between the superficial areas of spheres of different magnitudes. Suppose a force emanating from the centre of several concentric spheres, and diffusing itself through space. Taking it for an axiom, that Force is never lost, the supposed Force will become attenuated in proportion to the distance from the seat of power (the common centre), but will remain, in sum, undiminished. The sum of the force exerted on the surface of each sphere will then be the same. But these surfaces are in direct proportion to the squares of the radii of the spheres. The force, therefore, on any given part of any of these surfaces must, in its intensity, be in the inverse ratio of the radius—i.e., inversely as the distance. The undulations of light, heat, and sound, follow the same law. The first law of motion is also deducible, *à priori*, from the abstract idea of Force.

mathematical proportion in the rates of vibration of the different rays. What then should be the inference from the mass of data I have so hastily thrown together? Surely this; there is a correspondence between the plan of Nature and the mind of Man, which plainly indicates their common origin: and more, their common origin in a Mind cognate with that of Man; which has impressed its image on our little mental world as on the mighty Universe around us. I do not say, indeed, that this is *proved* as against any who maintain the origin of things in blind material force; the pattern and impress of whose action would be identical in both its products, Man and Nature. But such considerations are, in their way, as forcible, by way of illustration, as Paley's argument, based on mere utility.

Should Maphological Science at any time succeed in effacing the destinction between the organic and inorganic world, (no inconceivable result, when we remember that the phenomena of crystallization suggest an analogy between the two,) enlightened Faith will only find the very thing she was prepared for, and behind the study of *form*, chemistry begins to think of the ultimate revelation of a single *substance* of all created things. The modern doctrine, already glanced at, that all Force is of a single type, carries still further these notions of absolute cosmical unity; it being (as I have said) already ascertained that Heat, Electricity, Galvanism, Chemical affinity, and others of the physical Forces, can exchange effects with one another, and with Mechanical Force. No scientific mind, on which this doctrine of the unity and conservation of physical Force has taken hold, will ever part from it again. There is a growing conviction that Gravity, at one end of the scale, Vital Force at the other, will, in the end, appear reducible to a common form. Nature thus proving a very Proteus; and the varied forms of Force so many masks of a Dynamic Unity. Strange, after all, it is, that in this grand convergence of Scientific thought upon the one idea of perfect Unity, in form and substance, power and purpose, any man can fail to find increased assurance of that undying hope, that indestructible belief in,—

"That God, which ever lives and loves,
One God, one hand, one element,
And one far-off divine event,
To which the whole creation moves."

On the Changes effected in the Natural Features of a New Country by the Introduction of Civilized Races. By W. T. L. Travers, F. L. S.

(PART I.)

[*Lecture delivered at the Colonial Museum, Wellington, August* 7, 1869.]

In attempting to compress within the limits of a lecture so broad a subject as the character and extent of the changes effected by civilized man in the physical features and organic life of new countries, I am aware that I have undertaken no ordinary task, and on this ground alone I should have to crave your indulgence; but when, added to its inherent difficulties, I venture to state that my usual avocations are not akin to such investigations, I trust I may have a still further claim upon your good nature. In discussing the subject which I propose to bring under your notice, it is necessary that I should call your attention to the position which, so far as investigation has yet afforded light upon it, man has occupied on this globe from the most ancient times, for it must be manifest that although man, in his rudest stages of life, must long be dependent upon spontaneous productions for his means of subsistence, and that it is not until the arts of civilization have been considerably advanced, that he is able to bring under his dominion, more than a very limited number of the varied productions which are made to minister to his wants, or to his luxuries, yet nevertheless, in an enquiry like the present, we must take into account his primitive condition of existence. It has been well observed by a modern writer of great power, that "there are few scientific questions exciting so much interest as the origin and antiquity of man, and that, nevertheless, general as the interest is, there is no subject so furtively studied, and so unfairly dealt with." The same writer then shows that the influence of theological ideas has induced the great mass of enquirers to approach the subject with doubt and hesitation, and that even the learned societies of Europe exhibit an "uneasy tenderness" in dealing with it; and yet he points out how infinitely more important it is to acquire a knowledge of the origin, present condition, and probable future of man, than it is to possess the most intimate acquaintance with any of the other biological problems presented for our solution. And he argues that "if there be any irreverence in dealing with such questions as man's origin, antiquity, and destiny, that irreverence must rest with those who would circumscribe the range of reason, and seek by unworthy clamour to deter the human intellect from arriving at some conception, however faint, of those laws by which the Creator has chosen to sustain the phenomena of this marvellous universe. That man's relations to external nature, his relations to his God, and his relations to his fellow men, determine at once the range of his knowledge and the sum of his obligations; and that unless these relations be understood (and this is what science is always striving after), there never can be a complete fulfilment of the duties they involve. That it thus becomes truly pitiable to hear from certain quarters their misrepresentations of scientific aims and scientific conclusions. That, in fact, it is easier to bear than to hear them; and that one can scarcely avoid the conviction, that those who can misrepresent the opinions of others, in order to strengthen their own arguments, would have

little hesitation in falsifying facts to subserve a similar purpose. They talk of religion and infidelity! There is no profession of religion more offensive than that which, under the assumption of superior piety, attempts to vilify the honest convictions of others; the 'stand aside because I am holier than thou art' is, in general, void of reality, as it is wanting in Christian humility and charity. They talk of reconciliation between the utterances of science and religious beliefs, as if true religion and sound science ever have been or can be at variance. If religion means belief in certain dogmas and adherence to certain ritualistic forms, science and religion may often be in conflict; but, if, on the other hand, the exercise of religion consists in search after truth, regard to the relations in which we are placed to the universe, and devotion to the Great Author of all, then science and religion 'are at one, and need no reconciliation.'"

Agreeing entirely with these sentiments, I wish it to be borne in mind, that in the enquiries I propose to make in this lecture, I hold myself free from those theological dogmas which attempt to put arbitrary limits of time to man's presence upon earth, and to dictate the character in which he first appeared, and that I intend to deal with this part of the question under the light which the investigations of scientific men have recently thrown upon it.

Now we are told, by a late writer upon this part of our subject, that "the first appearance of man in Europe dates back to a period so remote, that neither history, nor even tradition can throw any light on his origin or mode of life," and we accordingly find that Præhistoric Archæologists are driven to acquire a knowledge of the character and habits of these early races, by examination of the remains they have left behind them.

Adopting this test, careful enquiry has enabled Archæologists to divide (by way of *ad interim* classification) the præhistoric period of Europe into four epochs.

1st. The "Palæolithic," in which man shared the possession of Europe, including England itself, with the Mammoth, the Cave Bear, the woolly-haired Rhinoceros and other now extinct animals.

2nd. The "Neolithic," in which men used beautiful polished stone weapons and other instruments, but did not until nearly the close of this age, possess any knowledge of metals except gold.

3rd. The "Bronze Age," in which bronze was used in the manufacture of arms and instruments of all kinds.

4th. The "Iron Age," in which iron had superseded bronze for many uses, though the latter metal was still used for ornamental purposes.

During the first of these periods we shall find that even in England man was the contemporary of the Elephant, the Rhinoceros, the Cave Bear, the Reindeer and the Hyæna. Mr. Lubbock in his recent work on "Præhistoric Times" tells us as follows:—

"In the year 1840, Mr. Godwin Austin communicated to the Geological Society a memoir on the Geology of the south-east of Devonshire, and in his description of Kent's Hole, near Torquay, he says that 'human remains and works of art, such as arrow heads and knives of flint, occur in all parts of the cave, and throughout the entire thickness of the clay; and no distinction founded on condition, distribution, or relative position, can be observed, whereby the human can be separated from the other reliquiæ, which included bones of the Elephant, Rhinoceros, Ox, Deer, Horse, Bear, Hyæna, and a feline animal of large size.

"The value," he truly adds, "of such a statement must rest on the care with which a collector may have explored; I must therefore state that my own researches were constantly conducted in parts of the cave which had never been disturbed, and in every instance the bones were procured from beneath

a thick covering of stalagmite; so far, then, the bones and works of man must have been introduced into the cave before the flooring of stalagmite had been formed.

"These statements, however, attracted little attention; and the very similar assertions made by Mr. Vivian, in a paper read before the Geological Society, were considered so improbable, that the memoir containing them was not published.

"In May, 1858, Dr. Falconer called the attention of the Geological Society to a newly-discovered cave at Brixham, near Torquay, and a committee was appointed to assist him in examining it. Grants of money were obtained for the same object from the Royal Society and Miss Burdett Coutts. In addition to Dr. Falconer, Mr. Pengelly, Mr. Prestwich, and Professor Ramsay were intrusted with the investigations. In September, 1858, a preliminary report was made to the Geological Society, but it is very much to be regretted that the results have not yet been published in extenso.

"The deposits in the cave were, in descending order:—

1. Stalagmite of irregular thickness,
2. Ochreous cave earth with limestone breccia,
3. Ochreous cave earth with comminuted shale,
4. Rounded gravel.

"The organic remains belonged to the following species:—

1. *Rhinoceros tichorhinus.* Teeth in considerable numbers and an astragalus.
2. *Bos sp.* Teeth, jaws, and other bones.
3. *Equus sp.* A few remains.
4. *Cervus tarandus.* The Reindeer, skull and bones.
5. *Cervus sp.* Horns.
6. *Ursus spelæus.* The Cave Bear; lower jaws, teeth, and the bones of a hind leg.
7. *Hyæna spelæa.* Lower jaws, teeth, fragments of skulls, and other bones.

"Several flint flakes were also found indiscriminately mixed with these bones, and according to all appearance, of the same antiquity. They occurred at various depths, from ten inches to eleven feet, and some of them were in the gravel, below the whole of the ochreous cave earth. One of them was found close to the bones of the left hind leg of a cave bear. The remains comprised not only the femur, tibia, and fibula, but even the knee-pan and astragalus were in their respective places. It is evident, therefore, that the limb must have been imbedded while in a fresh condition, or at least while the bones were held together by the ligaments. As, then, they must have been deposited soon after the death of the animal, it follows that, if man and the cave bear were not contemporaneous, the latter was the more recent of the two."

It is impossible, within the limits I have assigned to myself, even to enter upon the mass of evidence of a similar kind which has been adduced by numberless writers and enquirers in support of the great antiquity of man in Europe, and the foregoing extracts must be taken as only examples of the cases which have been investigated; but it is certainly impossible for us to resist the conviction that a length of time, enormous beyond all ordinary ideas on the subject, must have elapsed, since England and the western parts of Europe were inhabited by the elephant and the rhinoceros, animals of which no account is preserved even in the oldest known traditions or monuments. But although the circumstances, that many of the bones of each of these animals exhibit marks of having been cut and broken by man in order to extract the marrow, and that many of the implements which have been found associated with his remains, were made from such bones, may satisfy us that, even at that remote period, man had attained to a

position of power over the lower animals, we are nevertheless justified in supposing that these early men were greatly limited in number, and were living in a state of much degradation and barbarism. We may conclude, therefore, that nothing was done by people in such a condition to modify, in any material degree, the physical character of the country they inhabited, or which was calculated to subvert or even materially to affect the balance then existing amongst the various forms of contemporary organic life.

In the next age (the Neolithic) a great advance was made, for we find, (at all events during the later periods of this age), that man must have increased largely in numbers, and have made considerable strides in civilization. The principal monuments of the polished stone age in Europe are "Tumuli" or ancient burial mounds, the "Lake dwellings" of Switzerland, and the "Shell mounds" of Denmark, each of which is characterized by peculiarities, which can only be glanced at here.

There are also other remains of great interest which have been investigated by archæologists, such as the ancient "castles" and "camps" which crown so many of the hills in England; the great lines of embankment which cross many of the downs; the so-called Druidical circles, and the vestiges of apparently contemporary habitations, and the "Hut circles" and "Picts' houses" found in various places, but it is not my purpose to do more than refer to them.

With regard to the Tumuli, Mr. Lubbock tells us as follows:—"All over Europe wherever they have not been destroyed by the plough or the hammer, we find relics of præhistoric times, such as camps, fortifications, dykes, temples, tumuli, etc., many of which astonish us by their magnitude, while all of them excite our interest by the antiquity of which they remind us, and the mystery by which they are surrounded. Some few indeed, there are, such, for instance, as the Roman Wall in England, the Dannevirke, and Queen Thyra's tumulus, in Denmark, of which the date and origin are known to us, but by far the greater number, such as the Wansdyke, the 'temple' of Carnac in Brittany, the tumuli supposed to be those of Thor, Odin, and Freya at Upsala, and the great tumuli near Drogheda, are entirely præhistoric. Some of them doubtless, belong to the metallic period, some to that of stone, but it very rarely happens that we can attribute any of them, with reasonable probability, to one period rather than to another. This is particularly the case with ancient earthworks and megalithic temples or circles. The barrows, or Lows, on the other hand, frequently contain objects from which some idea of relative antiquity may be obtained. These ancient burial mounds, of which several typical examples are represented, are extremely numerous. In our own island they may be seen on almost every down; in the Orkneys alone it is estimated that more than two thousand remain; and in Denmark they are even more abundant; they are found all over Europe, from the shores of the Atlantic to the Oural mountains; in Asia they are scattered over the great steppes, from the borders of Russia to the Pacific Ocean, and from the plains of Siberia to those of Hindostan; in America we are told that they are to be numbered by thousands and tens of thousands, nor are they wanting in Africa, where the Pyramids themselves exhibit the most magnificent development of the same idea; so that the whole world is studded with these burial places of the dead. The Cromlechs, Dolmens, Cistvaens, are now generally regarded as sepulchral, and the great number in which these ancient burial places occur is very suggestive of their antiquity, since the labour involved in the construction of a tumulus would not be undertaken except in honour of chiefs and great men. Many of them are small, but some are very large; Silbury Hill, the highest in Great Britain, has a height of one hundred and seventy feet; but though evidently artificial, there is great doubt whether it is sepulchral.

"Mr. Bateman, in the Preface to his second work, has collected together

the most ancient allusions to burial ceremonies, and we see that 'Mound burial' was prevalent in the earliest times of which we have any historical record. Achan and his whole family were stoned with stones and burned with fire, after which we are told that Israel 'raised over him a great heap of stones unto this day. So the Lord turned from the fierceness of his anger.' Again, the king of Ai was buried under a heap of stones.

"According to Diodorus, Semiramis, the widow of Nirius, buried her husband within the precincts of the palace, and raised over him a large mound of earth. Some of the tumuli in Greece were old, even in the time of Homer, and were considered by him to be the burial places of the heroes. Pausanias mentions that stones were collected together, and heaped up over the tomb of Laius, the father of Œdipus. In the time of the Trojan war, Tydeus and Lycus are mentioned as having been buried under two earthen barrows. Hector's barrow was of stones and earth. Achilles erected a tumulus upwards of one hundred feet in diameter, over the remains of his friend Patroclus. The mound supposed by Xenophen to contain the remains of Alyattes, father of Crœsus, king of Lydia, was of stone and earth, and more than a quarter of a league in circumference. In later times, Alexander the Great caused a tumulus to be heaped over his friend Hephœstion, at the cost of 1200 talents, no mean sum, even for a conqueror like Alexander, it being £232,500 sterling. Virgil tells us that Dercennus, King of Latium, was buried under an earthen mound; and, according to the earliest historians, whose statements are confirmed by the researches of archæologists, mound burial was practised in ancient times by the Scytheans, Greeks, Etruscans, Germans, and many other nations. The size of the tumulus may be taken as a rude indication of the estimation in which the deceased was held; the Scotch Highlanders have still a complimentary proverb, 'Curri mi clach er do cuirn,' i.e., 'I will add a stone to your cairn.'

"What Schoolcraft says of the North American Indians is applicable to many savage tribes. 'Nothing that the dead possessed was deemed too valuable to be interred with the body. The most costly dress, arms, ornaments and implements, are deposited in the grave; 'which is always placed in the choicest scenic situations, on some crowning hill or gentle eminence in a secluded valley.' And the North American Indians are said, even until within the last few years, to have cherished a friendly feeling for the French, because, in the time of their supremacy, they had at least this one great merit, that they never disturbed the resting-places of the dead."

Now it is somewhat remarkable, (and parenthetically I may say the fact speaks strongly for the more extreme antiquity of the cave men,) that although in these ancient burial monuments the bones of animals are constantly found associated with those of men, yet most of the species to which such bones belonged had then undoubtedly been domesticated, and we no longer find the bones of the elephant or rhinoceros, of the bear, hyæna, or reindeer, with which the remains of the earlier men were constantly associated. These animals had evidently all disappeared, and in the meantime great advances had been made in various branches of art and civilization. No longer dependent upon spontaneous animal and vegetable growth for food and clothing, we find the people of this age protecting and propagating numerous forms of animal life, and we may assume that they warred upon such rival organisms as might have preyed upon these objects of their care, or might have obstructed the increase of their numbers. We may suppose too that these people carried on considerable agricultural pursuits, and that in doing so they encroached upon the forests which had covered the greater part of the surface of the countries they inhabited. We have, therefore, in our investigations of these early monuments, evidence of the first great modifications effected in the physical character and

organic life of our own mother country, and we are entitled fairly to assume that the consequences which ordinarily result from the felling of the woods, namely, changes in local climate, changes in the drainage of the soil, and changes in the external configuration of the ground, followed the action of these people, and rendered England a fitter abode for man, as a civilized being, than it had been during the earlier period I have referred to. We are, as I think I before observed, fairly justified in assuming, on the one hand, that during the age of the cave men, the population was extremely limited, and confined to localities easily accessible, while the country at large was ranged over by animals analogous to those which now occupy the jungles of India, and on the other, that during the later Neolithic period the population was large, extending over every part of the country, and that the earlier fauna and flora had given place to one more suited to the wants and uses of a semi-civilized people. How this change was brought about it is difficult to say, but that a very large period of time must have been concerned in producing it, is beyond all doubt.

The Neolithic age passes, by insensible gradations, into the age of Bronze.

Of the latter age Mr. Lubbock tells us as follows:—"There are four principal theories as to the Bronze age. According to some Archæologists, the discovery, or introduction of bronze was unattended by any great or sudden change in the condition of the people; but was the result, and is the evidence of a gradual and peaceable development. Some attribute the bronze arms and implements, found in Northern Europe, to the Roman armies, some to the Phœnician merchants; whilst others, again, consider that the men of the Stone age were replaced by a new and more civilized people of Indo-European race coming from the East; who, bringing with them a knowledge of bronze, overran Europe, and dispossessed—in some places entirely destroying—the original, or rather the earlier inhabitants.

"It is not, indeed, necessary to suppose that the introduction of bronze should have been effected everywhere in the same manner; so far, for instance, as Switzerland and Ireland are concerned, Dr. Keller and Sir W. R. Wilde may be quite right in considering that the so-called 'primitive' population did not belong to a different race from that subsequently characterized by the use of bronze.

"Still, though it is evident that the knowledge of bronze must necessarily have been preceded by the separate use of copper and of tin; yet no single implement of the latter metal has been hitherto found in Europe, while those of copper are extremely rare. Hungary and Ireland, indeed, have been supposed to form partial exceptions to this rule. The geographical position of the former country is probably a sufficient explanation; and as far as Ireland is concerned, it may perhaps be worth while to examine how far that country really forms an exception. In the great Museum at Dublin, there are 725 celts and celt-like chisels, 282 swords and daggers, and 276 lances, javelins, and arrow heads; yet out of these 1283 weapons, only 30 celts and one sword blade are said to be of pure copper. I say 'are said to be,' because they have not been analyzed, but are supposed to be copper only from the 'physical properties and ostensible colour of the metal;' indeed, one of these very celts, which was analyzed by Mr. Mallet, was found to contain a small percentage of tin. It is possible that for some of the purposes to which celts were applied, copper may have been nearly as useful as bronze, and at any rate it might sometimes have happened that from a deficiency of tin, some implements would be made of copper only.

"Taking these facts into consideration, Ireland certainly does not appear to present any strong evidence of an age of copper, while no one has ever pretended to find either there, or anywhere else in Europe, a trace of any separate use of tin.

"Sir W. R. Wilde himself admits it to be remarkable, that so few antique copper implements have been found, although a knowledge of that metal must have been the preliminary stage in the manufacture of bronze." He thinks, however, that "the circumstance may be accounted for either by supposing that but a *short* time elapsed between the knowledge of smelting and casting copper ore, and the introduction of tin and subsequent manufacture and use of bronze; or from the probability of nearly all such articles having been recast and converted into bronze subsequent to the introduction of tin, which renders them harder, sharper, and more valuable.

"There is, however, another circumstance which strongly militates against this theory of a gradual and independent development of metallurgical knowledge in different countries, and that is the fact which has been broadly stated by Mr. Wright, and which I may, perhaps, repeat here, that whenever we find the bronze swords or celts, whether in Ireland in the far west, in Scotland, in distant Scandinavia, in Germany, or, still further east, in the Sclavonic countries, they are the same—not similar in character, but identical. The great resemblance of stone implements found in different parts of the world may be satisfactorily accounted for by the similarity of the material, and the simplicity of the forms. But this argument cannot be applied to the bronze arms and implements. Not only are several varieties of celts found throughout Europe, but some of the swords, knives, daggers, etc., are so similar, that they seem as if they must have been cast by the same maker. It would have been easy to multiply examples of this similarity, and it is not going too far to say that these resemblances cannot be the result of accident. On the other hand, it must be admitted that each country has certain minor peculiarities. Neither the forms nor the ornaments are exactly similar. In Denmark and Mecklenburg, spiral ornaments are most common; farther south, these are replaced by ring ornaments and lines. The Danish swords generally have solid, and richly decorated handles, while those found in Great Britain terminate in a plate which was riveted to pieces of wood or bone. Again, the British lance heads frequently have loops at the side of the shaft-hole, which is never the case with Danish specimens. The discovery of moulds in Ireland, Scotland, and England, Switzerland, Denmark, and elsewhere, shows that the art of casting in bronze was known and practised in many countries. Under these circumstances, it appears most probable that the knowledge of metal is one of those great discoveries which Europe owes to the East, and that the use of Copper was not introduced into our Continent, until it had been observed, that by the addition of a small quantity of tin it was rendered harder and more valuable."

At whatever period the people of the Western countries of Europe may have acquired their first knowledge of bronze, it is clear that it must have been long anterior to any of which we have historical knowledge, nor does it much concern our enquiry except as regards the very great antiquity of the march of civilization. In the opinion of Professor Wilson (as we are told by Mr. Lubbock), "the ornamentation characteristic of the Bronze age, is decidedly Semitic rather than Indo-European. He lays considerable stress on two curious vase-carriages, one found in Sweden and the other in Mecklenburg, which certainly appear to have been very like the 'vases' made for Solomon's temple, and described in the first Book of Kings. Finally he believes that the use of war chariots, the practice of reaping close to the ear, and a certain mode of fishing, are all evidences of Phœnician intercourse."

We find, then, that the close of the Bronze age brings us to the dawn of historic times, and we are able, by examination of a variety of remains, to trace the progress of change in the physical character and organic life of the older countries of Europe, a subject full of interest, and one which is found to march,

hand in hand, with increasing civilization. But whilst I have thought it necessary thus to call your attention to this subject, I have done so chiefly for the purpose of suggesting a comparison between the rapid changes which are effected in new countries, as the result of their sudden occupation by civilized man, on the one hand, and the wonderfully slow process by which the physical character and organic life of our own country (for example), has been changed from the condition in which it appears to have existed at the time of the cave men, to that in which we now find it.

Let us now turn to the special subject upon which I propose to address you.

It is manifest that a subject so broad can, consistently with what is due to your patience, be only partially dealt with, and therefore, whilst I propose to offer some general reflections on the questions involved in it, I intend to confine myself, by way of example, chiefly to a consideration of the effect which has been produced upon these Islands.

In looking into the history of the discovery of these Islands, we are led to believe that the impressions made upon early voyagers were somewhat erroneous, for whilst it is true that the general aspect of a country, as regards its fertility, may as a rule, afford an idea of its capacity for sustaining a population, yet that capacity may be very different from what the immediate conformation and appearance of the country would lead the traveller to expect; height above sea level, exposure to special winds, and a variety of other causes, giving rise to the anomaly. Captain Cook (as you are aware) sailed round both of these islands, determining their size and figure, as well as their character and appearance, and the general opinion he arrived at was, that the whole country was one long chain of mountains with fertile valleys near the shores, and that it was chiefly covered with dense and in many places impenetrable woods. But even then our great navigator appreciated the advantages which these islands might, at some future time, offer as a field for settlement, and we have no reason to suppose that the most sanguine opinions which have since been formed on that subject, are not open to realization.

Except, however, by the Maoris, these islands remained entirely unoccupied until the year 1818, when the first missionary settlements were formed at the Bay of Islands, and until a short period before that, the only animals which had been introduced were the dog and the pig, and the only vegetables the kumera, the taro, and the gourd. How the Maoris obtained the dog is doubtful, but they owed the pig to Captain Cook, whilst the kumera, the taro, and the gourd, had certainly been brought with them upon their original migration to this country. It is a singular fact (so far at least as I know), that these islands produce no indigenous edible fruit or vegetable capable of being improved into value by cultivation, and, therefore, although the Maoris used a considerable variety of indigenous vegetable substances as food, these were quite insufficient for their ordinary purposes, and they were therefore compelled to devote a large portion of their time and attention to the cultivation of the few introduced plants to which I have before referred. But the population was not sufficiently numerous, and their cultivations were not sufficiently extensive to effect any great changes in the aspect or organic life of the country. It is true that for a long, but remote period, during the latter part of which man was certainly an actor on the scene, these islands had been the habitat of large struthious birds, of which the osseous remains are to be found distributed all over the country. What were the actual circumstances under which they disappeared we cannot say, although analogy leads us to suppose that the birds themselves, as well as their eggs, were diligently sought for as food in a country otherwise destitute of large animal life, and that they were gradually driven away from those grounds which alone afforded them the means of sustenance,

Taken on the whole, then, notwithstanding the cultivations of the Maoris, we may treat these islands as having been a virgin country, but little modified by the hand of man until the arrival of the European settlers.

Let us then enquire into the changes which have already been effected, and into the probable further changes which will in time be effected as the result of our colonization. This subject is necessarily twofold in its bearing, firstly, as regards the effect of colonization upon the native race, and secondly as regards its effect upon the indigenous fauna and flora.

In considering this subject I am tempted to draw your attention to the difference in the character of ancient and modern colonization, for it must not be supposed that the art of colonization is of purely modern invention, although, as you will find, the mode in which it is now carried out differs greatly from that which was practised by older civilized nations.

It has been urged by some political writers, that although the great nations of Europe have, within the last three centuries, sent colonies into almost every part of the habitable world, and have by this means subjected countries infinitely surpassing in extent those they have left, yet that we cannot compare the colonies of the ancients with those of the moderns, without being at once impressed with the conviction that the former renewed the human race, tempering it afresh, and beginning existence with all the advantages of youth, whilst the latter are born old, with all the jealousies, all the troubles, and many of the vices of the States from which they spring. That the colonies of the ancients, in every point of civilization, constantly rose above those who had given birth to them, whilst ours as constantly tend to fall below their founders; that the European colonies already large, are destined to become larger, but that in vain will be sought for in them, the virtues, the patriotism and the vigour which belonged to the first age of the world. They urge that the Greeks, and before them the Egyptians, founded a colony that it might be complete in itself, whilst we (speaking of existing European nations) design it to become part of another empire. They had constantly in view the welfare of the colonists; we, the advantage of the mother country. They wished the colony to depend upon itself with respect to its subsistence, defence, internal government, and all the principles of its development; we wish it to be dependent in every way, to subsist by commerce, and that this commerce should enrich the mother country; that it should be obedient to her orders, governed by her lieutenants, and that its citizens should receive even their education, in its highest branches, from their elder brothers. It is added, moreover, that whilst the colonies of the Egyptians, of the Phœnicians, of the Greeks, and even of the Romans, brought benefits to the people in whose countries they were established, ours bring calamities. That the first, by their contact, civilized the barbarians, whilst the modern Europeans have, wherever they have settled, barbarised the races they call barbarous, and in turn have become barbarised themselves. And it is urged, with much force and truth, that in their transactions with the aborigines, recent colonists have frequently sullied themselves by deceit and by abuse of force; that they go back in their agriculture and other arts, and that the general level of intelligence descends instead of rising.

Such writers further show that the first care of the ancient colonists was the choice of a site to build their city, for it was in cities they wished to live; and it was by means of cities that they spread the arts of the life of towns or civilization, and that the colonists, usually few in number as compared with the aborigines, and completely abandoned to themselves (for the mother country did not think of defending them), took care to build all their houses within the enclosure of the city, from which they went forth daily to cultivate the fields in their vicinity. Of course, the progress of such colonies in wealth

and numbers was slow as compared with modern ones, but their advance in the arts of civilization and of social life was never checked. In modern colonies, on the other hand, an immense extent of fertile land is sought for, and when obtained, is abandoned to the first occupier, who, relying upon the protection of the mother country, takes up a portion out of all proportion to his strength to cultivate, his capital to improve, or his wants to consume the produce. Masters at once of large tracts of country, which they hold, either by force or by purchase, they do not husband any of the benefits of nature. They clear the forests by fire, or by barking the trees, leaving them to decay where they stand; they abandon every system of manuring, of improvement, and of the rotation of crops. They apply themselves to benefit by the natural advantages of the soil, to which they sacrifice all others; they exhaust it by a succession of the same crops, and soon reduce the richest land to comparative sterility.

In the old colonies the different conditions of the citizens did not act as with us, or in our colonies, by a universal rivalry of one another, but, on the contrary, all felt a common interest, which had relation also to the aborigines. Intercourse with them could alone feed the colony at its commencement, and the means of gaining their friendship, of obtaining their confidence, and of establishing between them and the colonists common signs, or a conventional language, was the business of all and the urgent interest of all. At the same time it was from these aborigines that all danger arose, and watchfulness of them and defence against them, in the case of any sudden quarrel, were also interests felt by all. Now, on the contrary, wherever European colonization takes place, the colonists preserve all the incidents annexed to the different conditions of the citizens, both in relation to themselves and to the aborigines; all engage in rivalry as to rank and wealth, the latter frequently securing the former, with but little relation to those higher grounds upon which alone superiority of position ought to be admitted. Intercourse with the aborigines is maintained on a footing of friendship only until the colonists are strong enough to be independent of them, and then we see the former rapidly become degraded, those who had previously held high rank amongst them, first losing their status, whilst the race itself soon dies out. It is indeed a fact, which does not admit of doubt, which is even presented to us as a law of nature,—as a necessity,—that wherever a white race comes into contact with an indigenous dark race, on ground suitable to the former, the latter must disappear in a few generations. It will be said that the parallel I have drawn offers but a gloomy picture, but in its main features I think its truth is indisputable. However, I will now deal with my subject in those respects in which it may offer us more pleasing grounds of thought.

The general effects of human action in altering the surface of the earth and its natural productions have been thus eloquently described by Mr. George P. Marsh, an American author of great research and intelligence:—

"It is certain that man has done much to mould the form of the earth's surface, though we cannot always distinguish between the results of his action, and the effects of purely geological causes; that the destruction of the forests, the drainage of lakes and marshes, and the operations of rural husbandry and industrial art have tended to produce great changes in the hygrometric, thermometric, electric, and chemical condition of the atmosphere, though we are not yet able to measure the force of the different elements of disturbance, or to say how far they have been compensated by each other, or by still obscurer influences; and, finally, that the myriad forms of animal and vegetable life, which covered the earth when man first entered upon the theatre of a nature, whose harmonies he was destined to derange, have been, through his action, greatly changed in numerical proportion, sometimes much modified in form and product, and sometimes entirely extirpated.

"The physical revolutions thus wrought by man have not all been destructive to human interests. Soils to which no nutritious vegetable was indigenous, countries which once brought forth but the fewest products suited for the sustenance and comfort of man, while the severity of their climate created and stimulated the greatest number, and the most imperious urgency of physical wants—surfaces the most rugged and intractable, and least blessed with natural facilities of communication, have been made in modern times to yield and contribute to the sensuous enjoyments and conveniences of civilized life. The Scythia, the Thule, the Britain, the Germany, and the Gaul, which the Roman writers describe in such forbidding terms, have been brought almost to rival the native luxuriance and easily-won plenty of Southern Italy; and, while the fountains of oil and wine that refreshed old Greece and Syria and Northern Africa, have almost ceased to flow, and the soils of those fair lands are turned to thirsty and inhospitable deserts, hyperborean regions of Europe have conquered, or rather compensated, the rigours of climate, and attained to a material wealth and variety of product that, with all their natural advantages, the granaries of the ancient world can hardly have been said to have enjoyed.

"These changes for evil and for good have not been caused by great natural revolutions of the globe, nor are they by any means attributable wholly to the moral and physical action or inaction of the peoples, or, in all cases, even of the races that now inhabit these respective regions. They are products of a complication of conflicting or coincident forces, acting through a long series of generations; here improvidence, wastefulness and wanton violence; there, foresight and wisely guided persevering industry. So far as they are the purely calculated and desired results of those simple and familiar operations of agriculture and of social life, which are as universal as civilization—the removal of the forests which covered the soil required for the cultivation of edible fruits, the drying of here and there a few acres too moist for profitable husbandry, by draining off the surface waters, the substitution of domesticated and nutritious for wild and unprofitable vegetable growths, the construction of roads and canals and artificial harbours—they belong to the sphere of rural, commercial, and political economy more properly than to geography, and hence are but incidentally embraced within the range of our present enquiries, which concern physical, not financial balances. I propose to examine only the greater, more permanent, and more comprehensive mutations which man has produced, and is producing, in earth, sea, and sky, sometimes, indeed, with a conscious purpose, but for the most part, as unforeseen though natural consequences of acts performed for narrower and more immediate ends.

"The exact measurement of the geographical changes hitherto thus effected is, as I have hinted, impracticable, and we possess, in relation to them, the means only of qualitative, not quantitative analysis. The fact of such revolutions is established partly by historical evidence, partly by analogical deduction from effects produced in our own time by operations similar in character to those which must have taken place in more or less remote ages of human action. Both sources of information are alike defective in precision; the latter, for general reasons too obvious to require specification; the former, because the facts to which it bears testimony occurred before the habit or the means of rigorously scientific observation upon any branch of physical research, and especially upon climatic changes, existed."

Bearing these general views in mind let us apply them to the case of New Zealand. Before the settlement of these Islands by the Europeans they were inhabited by a race of savages, barbarous beyond conception, and practising rites of so foul a kind, that the very existence of such rites was often doubted by modern writers. And yet these people possessed characteristics

which were calculated to redeem them even in the eyes of civilized man. Brave to a fault, having a clear perception of the distinctions of rank, and therefore proud in character, they also possessed a large amount of intellectual capacity, and even of latent moral character. Acute in their understanding and comprehension, they rapidly fell in with many of the arts and habits of the colonists, but, unaccustomed to the restraints of civilized life, and in the habit of indulging with little check their natural impulses, they have found it difficult to adopt as fully, as their own appreciation of them would otherwise lead them to do, the social habits of the Europeans. Unfortunately too we have shown too little regard to their feelings of pride and nationality, and by the ridicule with which we have treated their habits and manners, we have driven them to adopt, as individuals as well as collectively, a position of isolation, if not of hostile feeling towards us. Without having introduced amongst them any form of government more suited to promote and foster our intercourse with them, we have broken down the power and influence of the greater chiefs, and have induced a consequent disorganization of their own social condition, which is producing unfortunate results. I wish, however, not to be misunderstood in this matter. It has been admitted by foreign political economists that the English are the only nation which, of late years, have felt any true sympathy for the people amongst whom they have sent their colonists, who have acknowledged their rights, and who have seriously proposed to civilize them, to protect them, and to make them happy. But in their efforts to effect these objects from a distance, and with the imperfect knowledge they necessarily possessed of the original character of the native races, and of the changes which contact with civilization would produce upon them, they have constantly overlooked many important considerations. They have forgotten that those to whom the task of protection was entrusted, would naturally place themselves in antagonism to the advance of the colonists, whilst the latter would certainly view with distrust and dislike, those who stood in the way of their efforts to acquire wealth ; and thus, between the two, the natives would come to grief. Our colony (as it appears to me) has exhibited to some extent, this unfortunate phase of English philanthropy, and yet elements of hope present themselves to our view. It is not, however, my purpose to pursue any further this enquiry, which belongs rather to the political economist and the legislator, than to the student of geography and natural history, and I will proceed at once to call your attention to the general physical appearance of these Islands, and the character of their fauna and flora before the introduction of European civilization, and to the changes which have since been effected and are now in progress. In doing this, however, I propose to disregard such alterations as had resulted from their occupation by the native race.

Stretching from the thirty-fourth to the forty-seventh degree of south latitude, in a general north and south direction, with an average breadth in the Middle Island not exceeding 120 miles, and in the North Island (except above Auckland) of about 150 miles, the whole extent may be treated as a great mountain chain divided by Cook's Strait. In the North Island there are, in the western and north-western sides of this chain, several large volcanic cones, some of the mountains of which rise to altitudes varying from 4000 to 9000 feet above sea level, and of which Tongariro, nearly in the centre of the greater mass of the island, is still active. In the Middle Island the great mountain chain extends from the north (in the form of spurs radiating from the Spencer mountains on the west side, and from the Kaikoura mountains on the east) to the extreme south, attaining its greatest elevation in Mount Cook, whilst in many places it reaches an altitude of 10,000 feet, and has a general elevation of from 6000 to 8000 feet. In the Middle Island, with the exception of the Canterbury plains and the undulating country to the north and south of

them, stretching on the one side to the Waiau river, and on the other to the south of Otago, there is little in the general appearance of the country to induce any high idea of its capacity for sustaining a large agricultural population; nor does the North Island present, at first sight, any better field, although on the eastern side it also possesses plains, in the Hawke's Bay and Wairarapa districts, and the country on the West Coast from Otaki to the Manukau probably contains some of the most fertile land in the world. The eastern sides of both islands, including the slopes of the mountain chains, contain large tracts of grassy country available for pastoral purposes, but, as a rule, the whole of the western sides are clothed with dense and, in many parts, impenetrable forest. It is found, however, that the slopes of the mountain chains contain excellent soil, and that when cleared of the forest growth, they are capable, under proper cultivation, of being converted into valuable pasture land. The whole country may be said to be well, and in many places, profusely watered, and the native growth is usually luxuriant to a degree.

It must be manifest that in islands having so large a range of latitude, there must be a corresponding range in climate, and accordingly we find that whilst in the extreme north the climate is sufficiently warm to ripen freely many of the fruits of the tropics, and that, even in the neighbourhood of Auckland, the citron, the orange, and the guava mature their fruit, so, as we pass to the South, we find it eminently suited to the production of all the varied fruits and vegetables which make the luxury of temperate climates. It would lead me too far (nor indeed is it necessary in addressing a New Zealand audience), were I to attempt any very detailed description of the physical aspect of the country or its climate, and the general outline I have given will be sufficient for my purpose. To the first colonists it undoubtedly presented the appearance of a country in an almost untouched condition, covered, in its forest lands, with the growth of untold centuries, and in its open lands with grasses, ferns, and swamp-loving plants to which their eyes were totally unused, and which differed in all important respects from the wild growth of Europe. I had intended to describe, in some detail, the organic natural productions of the country, but I began to find that this lecture would stretch to an inconvenient length, and I must leave your local knowledge on this point to fill up the void. This is perhaps the less important, for with the exception of grasses, made available in their uncultivated state for depasturing purposes, and of timber used for building and farm purposes, it may be said, that little has been done towards utilizing them, and still less towards ascertaining their properties and value. Within the last two years the fibre of the *Phormium tenax* has been prepared as an article of export, and, if properly managed, it will probably yield an excellent return, but I know of no other natural vegetable production of the country (unless we can give that name to Kauri gum) which has yet been turned to account for purposes of foreign export. You are all aware that the mineral resources of these islands are very large and very varied, but it is clear that the natives had no knowledge which would enable them to turn those resources to account, before the arrival of the Europeans, for we found them still using stone and wooden weapons, similar to those which, in Europe, characterize the middle epoch of the Neolithic age.

Such, in brief, was the condition of the country when civilized man under the impulses which ordinarily inspire modern colonists, was poured upon it—and now how changed has it all become? Instead of the miserable "pahs" and "kaingas" of an uncivilized and utterly barbarous race, we have, in most of the great ports of the country, flourishing towns, each inhabited by thousands of Europeans, and many of them possessing buildings which present all the characters of wealth and durability. Instead of the solitary canoe of the native fisherman, or the fleet of a war party intent upon murder and rapine, our

waters teem with ships busily engaged in the peaceful work of commerce, whilst large and valuable works in our various ports give facilities for the carrying on and development of that commerce. Instead of our great tracts of native pasture lying idle, and yielding sustenance to no useful living thing, they are now roamed over by and maintain large herds of cattle and flocks of sheep. Instead of the desolate, but luxuriant vegetation of the swampy ground along many parts of our sea board, and the impenetrable forests of many of our valleys, we have rich fields, producing the grain and other crops of temperate Europe. Instead of the narrow bush track, along which the savage travelled on his mission of revenge, we have roads penetrating the country in all directions, facilitating the maintenance of that intercourse, which is essential to the progress of the community in wealth and civilization. Instead of the mineral resources of the country lying idle, we have thousands of men busily engaged in extracting them from the soil, and thus, whilst enriching themselves, contributing by their labours to the wealth of others. We have, indeed, on all sides of us abundant evidence that the energies of a European race are rapidly converting a country which in its natural state scarcely afforded means for the sustenance of man, into one capable not only of maintaining a contented population, but of affording the materials for an extended foreign commerce.

But it is not merely these more material and directly apparent effects that concern us. Many, if not all of you, have heard of the Darwinian theory as applied to the origin of species. This theory teaches us that a struggle for existence is constantly going on between all the varied organisms, both animal and vegetable, which occupy any particular Zoological or Botanical province, and that only such organisms can ultimately succeed in maintaining a place, as may happen, for the time being, to possess some point of vantage beyond the rest. Of course time is an important factor in this theory, and in order to appreciate its bearing upon the origin of species, the observer must be prepared to admit millions of years for the work. In a country like New Zealand, placed at such a distance from other countries as to preclude the risk of invasion, except through the agency of man, it must be manifest that this struggle would be carried on under peculiarities little likely to be observed in other places, and the results already caused by the introduction of new and rival organisms satisfies me that the indigenous flora and fauna even on their own ground, are unable to cope with the intruders. I cannot but think that the former had reached a point at which, like a house built of incoherent materials, a blow struck anywhere shakes and damages the whole fabric. The "Kiore" has been replaced, if not destroyed, by the European rat; the European honey bee now swarms in our forests, taking the food of the meliphagous birds, which are already diminishing palpably in numbers, whilst the facility afforded by the immense epiphytical growth upon the forest trees enables the rat also to aid in this destruction by devouring the eggs and young birds. The forests too contain large numbers of wild pigs, cattle, and goats. The former root up the ground, destroying the seedling trees, whilst the latter browse upon the young shoots and foliage, and even eat the bark of the smaller trees in a manner tending greatly to limit their growth. Following in their wake come many of the hardy vegetable organisms of Europe which spring up on all sides as rivals to the remaining indigenous plants, and thus the latter are exposed to a contest under circumstances in which defeat is almost certain. Such in effect, is the activity with which the introduced plants are doing their work, that I believe if every human being were at once removed from the Islands for even a limited number of years, looking at the matter from a geological point of view, the introduced would succeed in displacing the indigenous fauna and flora.

I must now bring my task to a close, and in doing so again apologize to

you for the imperfect manner in which it has been performed. I know that I have left untouched a huge mass of matters bearing upon the question, under consideration to which I ought, in justice to you, to have referred; but the haste with which, and the difficulties under which this lecture has been written, must be my excuse both for sins of omission and of commission. I will only add, that in all which is taking place around us, we see the energies of our race forming a new and vigorous state. The face of the country, the life native to its soil, and the aboriginal race which claimed it, are all being modified, effaced, and displaced. The intrusive race has indeed wrought mightier changes in the third part of a century than the aborigines would have effected had they remained for another thousand years unvisited by civilized man.

The rapidity of such changes, too, strikes the on-looker with astonishment, and is inconceivable to those who have not witnessed it for themselves. In 1839 the "Tory" first visited Cook's Straits on a colonizing mission, and then found the natives engaged in a bloody feud at Waikanae, and exhibiting the most forbidding habits, natural to savage life. All was strange, wild, and savage. Thirty years have elapsed since then, and already large cities have risen in many parts of the Islands. Everywhere the broad sheets of the press are engaged in diffusing information, and in discussing the politics and wants of a civilized people, where so recently the hut of the savage was the only evidence of the presence of man. The clearing, the farm, the industrious settlement have displaced the scanty cultivation of the Maori, and his ephemeral hut. The progress of a single year outspeeds the work of past centuries, and amid the charred stumps of our hill-side forests, and the rough clearings of our farms, fancy may trace the handsome villas, and luxurious plantations of wealthy landed proprietors. Already we have seen the iron horse doing its work in the colony, whilst the mind of the people is intent on extending the range of its work to the immense tracts of rich country, still too distant, for full value, from the centres of population. If, by the intrusion of the vigorous races of Europe, smiling farms and busy marts are to take the place of the rough clearing and hut of the savage, and the millions of a populous country, with the arts and letters, the matured policy, and the ennobling impulses of a free people, are to replace the few thousands of the scattered tribes now living in an apparently aimless and unprogressive state, even the most sensitive philanthropist may learn to look with resignation, if not with complacency, on the extinction of a people which, in the past had accomplished so imperfectly every object of man's being. If the Maoris can, so far as wise policy and a generous statesmanship can accomplish it, be admitted to an equal share with the intending colonizer in all the advantages of a progressive civilization; then we may look with satisfaction at the close of that long night time during which this country gave birth to no science, no philosophy, no moral teaching, and hail the dawn of centuries in which it is to claim a place in the commonwealth of nations, and bear a part in the accelerated progress of the human race.

(PART II.)

[*Lecture delivered October* 16, 1869.]

I will now proceed to discuss, at greater length, that part of the subject which more especially referred to the effects likely to be produced upon the fauna and flora of this country, by the introduction of competing foreign organisms. In order that you may be able satisfactorily to follow my observations, it will be necessary that I should, in the first place, call your attention shortly to the divisions and classification of the organic world, and the laws which govern its distribution; and, somewhat more fully, to the views

originated by Mr. Darwin, and now generally entertained by naturalists, in regard to the "Origin of Species," for (as you will find in the sequel) I have assumed that many of the principles of action which his theory is intended to elucidate, are directly engaged in producing the changes which I propose to notice, both as having been already effected, and as being likely to ensue in the course of time.

You are all doubtless aware, that organic nature is broadly divisible into two great branches, namely, animal and vegetable life, the study of the former being termed Zoology, and of the latter Botany. It is true, that at the extreme confines of each of these two kingdoms, as we descend from the higher to the lower forms, even this broad distinction is apparently obliterated, and we find, in effect, that naturalists were long in doubt to which of the two kingdoms some of the lowest observed organisms, ought properly to be assigned. This, however, is a matter which little concerns our present enquiry, though it certainly helps to demonstrate the accuracy of that admirable analysis of the organic world, which has lately been exhibited to us by our great physiological writers, and from which we have learnt, not only that the infinite diversity both of animal and vegetable life which peoples the globe, may all be brought down to the primordial form of a single cell, but also that both may be reduced into, and are, in fact, composed of the same elementary constituents.

It had, however, been known long before reaching this more advanced analysis, that the enormous multiplicity both of animal and vegetable life, could, in each case, be reduced to a few types of construction, and, indeed, the types thus established have constituted the bases of all those systems of classification by the elaboration of which we have been enabled to study the organic world in detail.

Looking to the probability that the vegetable kingdom yielded to man his earliest means both of sustenance and shelter, it has been assumed by every writer on Natural History, that it was the first to engage his attention, and become his study, and that the necessity of distinguishing between such forms as were useful and such as were injurious, led to the first rude classifications of vegetable life. "By placing together individuals apparently identical in form (says Dr. Lindley), and having regard to the uses they could be applied to, species were distinguished, and by applying a similar process to the species themselves, groups analagous to what we now call genera were obtained. The last step was to constitute classes, which were recognized under the well known names of 'grass and herbs yielding seed, and fruit trees yielding fruit.'"

It will not be necessary for me to point out how, step by step, the more complete systems of classification now adopted by naturalists were arrived at, how the artificial system of Linnæus was replaced by the natural systems of succeeding enquirers, until we are gradually reaching a more exact knowledge of the plan of nature, it being sufficient for my purpose to call your attention broadly to those systems, and to the circumstance that, in every case, they virtually terminate with what is called "species."

The animal kingdom has been primarily divided into two great Sub-kingdoms or Provinces, namely, the Vertebrata and the Invertebrata, each of which has been again subdivided into classes, orders, families, and species.

The vegetable kingdom has also been primarily divided into two sub-kingdoms, namely, into asexual or flowerless, and sexual or flowering plants, each comprising a number of distinct classes, orders, genera, and species. With the latter term indeed, whether in the Animal or Vegetable Kingdoms, classification proper has been supposed to end, although all systematists have recognized the existence of varieties, even in a state of nature.

Now it might be supposed, looking more particularly to our recent

great advance in knowledge of the physiology and anatomy both of animals and plants, that, for purposes of classification, there would be little difficulty in defining the term "species" as applied to any particular class or group of organisms, but this is far from being the case, for we find, that the most acute and diligent enquirers, after careful study of the question, have acknowledged that this term can only be applied arbitrarily and for the sake of convenience merely, to some set of individuals closely resembling each other, and that in its necessary application by systematists it does not essentially differ from the term "variety" which, in comparison with mere individual differences, is usually given quite as arbitrarily to forms somewhat less distinct and more fluctuating.

This point has been made the subject of most elaborate investigation by Mr. Darwin, in his volume on the "Origin of Species," in which he has brought together a great mass of facts to prove that all classes of organisms exhibit a greater or less degree of variability, and to show the consequent difficulty of giving any conclusive or satisfactory definition of the term "species,"—the general conclusions he arrived at being thus stated,—"Finally, then, varieties have the same general character as species, for they cannot be distinguished from species—except, firstly, by the discovery of intermediate linking forms, and the occurrence of such links cannot affect the actual characters of the forms which they connect; and except, secondly, by a certain amount of difference, for two forms, if differing very little, are generally ranked as varieties, notwithstanding that intermediate linking forms have not been discovered; but the amount of difference considered necessary to give to two forms the rank of species, is quite indefinite. In genera having more than the average number of species, in any country, the species of these genera have more than the average number of varieties. In large genera the species are apt to be closely, but unequally allied together, forming little clusters round certain species. Species very closely allied to other species, apparently have restricted ranges. In all these several respects the species of large genera present a strong analogy with varieties. And we can clearly understand these analogies, if species have once existed as varieties, and have thus originated: whereas, these analogies are utterly inexplicable if each species has been independently created.

"We have, also, seen, that it is the most flourishing or dominant species of the larger genera which, on an average vary most; and varieties, as we shall hereafter see, tend to become converted into new and distinct species. The larger genera thus tend to become larger; and, throughout nature, the forms of life which are now dominant, tend to become still more dominant by leaving many modified and dominant descendants. But, by steps hereafter to be explained, the larger genera also tend to break up into smaller genera. And thus, the forms of life, throughout the Universe, become divided into groups subordinate to groups."

Flourens, in his paper on "La Quantité de vie sur le Globe," also tells us, "that every species manifests two tendencies, namely, a tendency to vary and a tendency to transmit to succeeding generations the acquired modifications;" and he, properly, observes, "that if the acquired variations and modifications of each generation could not be transmitted to its descendants, such variations and modifications would remain mere individual traits, and would never become the characteristics of a race." Flourens, however, does not appear to have seen the full effect of these views as to the variability of species, for he assumes that such variations only affect what he terms "superficial characteristics," and that they are at all times easily detected, whilst he urges that "the unity, identity, and reality of a species is always determinable by the presence or absence of the more deep seated characteristic of continuous fecundity."

In order to illustrate the difficulty referred to by Mr. Darwin, I will call your attention to some instances in nature.

Experiment has shown that the Zebra, the Hemionus, the Ass, and the Horse, can mutually produce young, but that their produce, notwithstanding certain exceptional instances of further fertility which have been sufficiently well authenticated, cannot perpetuate themselves, and yet no naturalist holding a position of eminence at the present day, would venture to deny that these four races of animals have all descended from common ancestors.

Here, then, we have an example of very limited divergence in outward form, accompanied by great limitation in fecundity, and naturalists may, notwithstanding their admitted descent from common ancestors fairly claim to treat each of these animals as having reached the position of a separate species.

With the dog, on the other hand, although the external differences between many forms, as, for example, the Bull dog, the Turnspit, and the Greyhound, are far greater and more striking than those which we observe between the Horse, the Ass, and the Hemionus, yet the former are always perfectly fertile in interbreeding, and the cross-breeds perpetuate themselves. Here then we have an example of considerable divergence in outward form, in the "superficial characteristics" of Flourens, without any apparent interference with fecundity, and, yet, in this case, although naturalists have also arrived at the conclusion that all existing varieties of the dog are descended from common ancestors, they also treat each of these animals as a separate species.

If, therefore, continuous fecundity were *the* essential characteristic in the determination of "species," then the Horse, the Ass, and the Hemionus ought to be treated as separate species, whilst the Bull dog, and the Greyhound, and all the other innumerable and peculiar forms of Dog found in every corner of the globe, ought only to be ranked as varieties of one species.

Such an adherence to any arbitrary rule is, however, unnecessary for purposes of classification, though it bears strongly upon other points in the theory propounded by Mr. Darwin to which I propose hereafter to call your attention. But it is not only to animal life that the foregoing observations extend. Although more difficult to understand in their application, the same rules must be adopted in dealing with the classification of vegetable organisms. Take, for example, plants belonging to the natural order Compositæ which includes the Daisy, the Groundsel, and other allied forms. Here on the table you have four specimens, very similar in outward form, and at least as closely allied in essential points of structure as the Horse and his congeners.

Now, although we have not yet attempted to ascertain experimentally whether these four forms would produce cross-breeds, I think few naturalists would for one moment suppose that they would. If this be so, then we have here an example of still greater divergence in fecundity, whilst we have no difficulty in believing that these several forms, as well as all other plants belonging to the same order, had a common origin. Indeed it would be easy to bring together numberless examples, from the book of nature, of incomplete fecundity with slight divergence in outward form or general structure; of complete fecundity with great divergence in outward form; and complete sterility with great similarity in most of those characteristics, which are used by naturalists for purposes of classification, while, at the same time, we should have little hesitation in admitting the descent of all the species of each class, from common ancestors. I will merely add further, that whilst all great naturalists admit that it is quite chimerical to suppose that we can construct any arrangement which shall be an absolutely correct expression of *the* plan of nature, yet they also allow that we can, by carrying into effect with care and

skill certain well recognized principles, construct what may fairly be termed a *natural system.*

In such a system groups of species are collected into genera, groups of genera into orders, and groups of orders into classes; each order comprising a number of genera distinct from those of the others, but which, nevertheless, are distinguished by certain general characters different from those of any other orders of plants, characters, too, which are preserved through every existing modification of form.

I have thus shown you that the organic world is primarily divided into two great kingdoms; that each of these is subdivided into classes, orders, genera, and so-called species; and that every species is held to possess two leading tendencies, the one to vary, and the other to accumulate such variations where profitable, by transmitting to its descendants the modifications resulting from variation. I now purpose, in the next place, to call your attention shortly to certain observed facts in relation to the geographical distribution of animals and plants.

The Abbé Domenech has observed that "if Eden were the birthplace of mankind, it certainly was not the birthplace of the whole animal and vegetable creation, for," he says, "the works of God invariably bear the witness of Divine Wisdom, and to have created in Eden the Reindeer of Lapland, the Lama of Peru, the Kangaroo of Australia, and the Ostrich of the Sahara, would have been as useless as to people the coasts of Tyre and Sidon with the Whale of Greenland, the Tortoise of the Gulf of Mexico, and with fishes which only live in Intertropical and Hyperborean regions."

"In considering the distribution of organic life over the globe," says Mr. Darwin, "the first great fact which strikes us is, that neither the similarity nor the dissimilarity of the inhabitants of various regions can be accounted for by their climatal and other physical conditions. Of late, almost every author who has studied the subject, has come to this conclusion. The case of America alone would suffice to prove its truth; for, if we exclude the northern parts where the circumpolar land is almost continuous, all authors agree that one of the most fundamental divisions in geographical distribution is that between the New and Old Worlds; yet if we travel over the vast American Continent, from the central parts of the United States to its extreme southern point, we meet with most diversified conditions; the most humid districts, arid deserts, lofty mountains, grassy plains, forests, marshes, lakes, and great rivers, under almost every temperature. There is hardly a climate or condition in the Old World which cannot be paralleled in the New, at least as closely as the same species generally require; for it is a most rare case to find a group of organisms confined to any small spot, having conditions peculiar in only a slight degree; for instance, small areas in the Old World could be pointed out hotter than any in the New World, yet these are not inhabited by a peculiar fauna or flora. Notwithstandsng this parallelism in the conditions of the Old and New Worlds, how widely different are their living productions!

"In the Southern Hemisphere, if we compare large tracts of land in Australia, South Africa, and Western South America, between latitudes 25° and 35°, we shall find parts extremely similar in all their conditions; yet it would not be possible to point out three faunas and floras more utterly dissimilar. Or again, we may compare the productions of South America, south of latitude 35° with those north of 25°, which consequently inhabit a considerably different climate, and they will be found incomparably more closely related to each other, than they are to the productions of Australia or Africa under nearly the same climate. Analagous facts could be given with respect to the inhabitants of the sea."

The author from whom I have just quoted, then points to certain facts

which bear, in a close and important manner, upon the differences between the productions of various regions, and shows how barriers of any kind which prevent free migration, favour,—under the operation of the laws which he proceeds to point out and elucidate—the production of organisms presenting marked differences from each other, without destruction of those general affinities, which the same species (using this term in the sense now applied to it by advanced systematists) present at different points and stations.

In like manner, Sir Charles Lyell, in the last edition of his "Principles of Geology" calls special attention to the geographical distribution of species, and to the causes which affect it, and I cannot do better than quote some passages from that work also. And here I may say, that I have the less hesitation in using extracts from the writings of such authors as Darwin and Lyell, because it would be impossible for me to convey in more clear and apposite language, the matters involved in these extracts.

Sir C. Lyell says, "Although in speculating on 'philosophical possibilities,' said Buffon, writing in 1755, the same temperature might have been expected, all other circumstances being equal, to produce the same beings in different parts of the globe, both in the animal and vegetable kingdoms, yet it is an undoubted fact, that when America was discovered, its indigenous quadrupeds were all dissimilar to those previously known in the Old World. The elephant, the rhinoceros, the hippopotamus, the cameleopard, the camel, the dromedary, the buffalo, the horse, the ass, the lion, the tiger, the apes, the baboons, and a number of other mammalia, were nowhere to be met with on the new continent; while in the old, the American species, of the same great class, were nowhere to be seen—the tapir, the lama, the pacari, the jaguar, the couguar, the agouti, the paca, the coati, and the sloth.

"These phenomena, although few in number, relatively to the whole animate creation, were so striking and so positive in their nature, that the great French naturalist caught sight at once of a general law in the geographical distribution of organic beings, namely, the limitation of groups of distinct species to regions separated from the rest of the globe by certain natural barriers. It was, therefore, in a truly philosophical spirit that, relying on the clearness of the evidence obtained respecting the larger quadrupeds, he ventured to call in question the identifications announced by some contemporary naturalists, of species of animals said to be common to the southern extremities of America and Africa.

"In order to appreciate the importance and novelty of the doctrine, that separate areas of land and water were the abodes of distinct species of animals and plants, we must look back to the times of Buffon and see in what crude conjectures even so great a naturalist as his illustrious contemporary Linnæus indulged, when speculating on the manner in which the earth may first have become peopled with its present inhabitants. The habitable world was imagined by the Swedish philosopher to have been for a certain time limited to one small tract, the only portion of the earth's surface that was as yet laid bare by the subsidence of the primeval ocean. In this fertile spot the originals of all the species of plants which exist on this globe were congregated together with the first ancestors of all animals and of the human race. 'In quâ commodè habitaveurit animalia omnia, et vegetabilia lœte germinaveruit.' In order to accommodate the various habits of so many creatures, and to provide a diversity of climate suited to their several natures, the tract in which the creation took place was supposed to have been situated in some warm region of the earth, but to have contained a lofty mountain range, on the heights and in the declivities of which were found to be all temperatures and every climate, from that of the torrid to that of the frozen zone. There are still perhaps some geologists who adhere to a notion once very popular, that there are signs of a

universal ocean at a remote period after the planet had become the abode of living creatures. But few will now deny that the proportion of sea and land approached very nearly to that now established long before the present species of plants and animals had come into being.

"The reader must bear in mind that the language of Buffon, in 1755, respecting 'natural barriers' which has since been so popular, would be wholly without meaning had not the geographical distribution of organic beings led naturalists to adopt very generally the doctrine of specific centres, or, in other words, to believe that each species, whether of plant or animal, originated in a single birthplace. Reject this view, and the fact that not a single native quadruped is common to Australia, the Cape of Good Hope, and South America, can in no ways be explained by adverting to the wide extent of intervening ocean, or to the sterile deserts, or the great heat or cold of the climates, through which each species must have passed, before it could migrate from one of those distant regions to another. It might fairly be asked of one who talked of impassable barriers, why the same kangaroos, rhinoceroses, or lamas, should not have been created simultaneously in Australia, Africa, and South America? The horse, the ox, and the dog, although foreign to these countries until introduced by man, are now able to support themselves there in a wild state; and we can scarcely doubt that many of the quadrupeds at present peculiar to Australia, Africa, and South America, might have continued in like manner to inhabit all the three continents, had they been indigenous in each, or could they once have got a footing there as new colonists."

I might multiply quotations from these and other authors occupying the foremost rank in the scientific world, in order to show that both sea and land may, in the present condition of organic nature in every part of the globe be properly divided into what have been termed distinct Zoological and Botanical Provinces, each occupied by special groups of animals and plants which, however, have been found to exhibit, in each case, a certain amount of coincidence in range of species; and, indeed, it is urged, that no hypothesis respecting the origin of species can possibly be satisfactory, which does not show, in the first place, how species and genera, and ofter larger groups, now range in space in such a manner as to lead to the implication that they have spread from a limited area termed a "centre of creation," until their progress has been stopped either by some physical barrier or other condition hostile to further extension; and which does not account, in the next place, for the restriction of peculiar generic forms to certain parts of the globe.

There is nothing more striking to the naturalist, moreover, than the fact, now well determined, that the rules established by observation in regard to the distribution of living organisms are those which have also been found to obtain in regard to fossil forms, and it has thence been fairly argued, and as I believe sufficiently well proved, that the intimate connection observed between the existing and the fossil forms within each particular province points to the certainty that the former are of derivative origin, and are not primordial or independent creations. I am compelled, having regard to the length of a lecture, arbitrarily to limit my observations upon this part of the subject, but I think that even without going into the reasons urged by Mr. Darwin and others, as to the improbability of our being able to identify the actual fossil ancestor of any living species, or to trace its descent through past geological epochs, I have sufficiently shown to you the probability that the forms of life now occupying any particular Zoological or Botanical Province may be looked upon as the descendants of those which have occupied it during past geological periods, and that the differences between the existing and fossil forms are due to the operation of the laws so clearly expounded by Mr. Darwin. Of course in assuming such a probability, time becomes an important factor, and those

who have been accustomed to trust to Usher's chronology, and to look upon our globe, at least, as having been created within a few thousand years, will be utterly unable to accept, because they cannot comprehend, such a hypothesis. But whilst each particular province presents, as I have explained to you, its own peculiar generic forms, we constantly find a large degree of affinity existing between the organic life occupying more extended areas comprising frequently several of such provinces. Upon this point (in special connection with the affinities of the flora of New Zealand) I quote as follows from Dr. Hooker's "Introductory Essay" to his "Flora of New Zealand," as published in 1853 :—

"Of all the branches of Botany, there is none whose elucidation demands so much preparatory study, or so extensive an acquaintance with plants and their affinities, as that of their geographical distribution. Nothing is easier than to explain away all obscure phenomena of dispersion by several speculations on the origin of species, so plausible that the superficial naturalist may accept any of them ; and to test their soundness demands a comprehensive knowledge of facts, which, moreover, run great risk of distortion in the hands of those who do not know the value of the evidence they afford. I have endeavoured to enumerate the principal facts that appear to militate against the probability of the same species having originated in more places (or centres) than one ; but in so doing I have only partially met the strongest argument of all in favour of a plurality of centres, viz., the difficulty of otherwise accounting for the presence of two widely sundered localities of rare local species, whose seeds cannot have been transported from one to the other by natural causes now in operation. To take an instance, how does it happen that Edwardsia grandiflora inhabits both New Zealand and South America ? or Oxalis Magellanica both these localities and Tasmania ? The idea of transportation by aerial or oceanic currents cannot be entertained, as the seeds of neither could stand exposure to the salt water, and they are too heavy to be borne in the air.

"Were these the only plants common to these widely sundered localities, the possibility of some exceptional mode of transport might be admitted by those disinclined to receive the doctrine of double centres ; but the elucidation of the New Zealand Flora has brought up many similar instances equally difficult to account for, and has developed innumerable collateral phenomena of equal importance, though not of so evident appreciation. These, which all bear upon the same point, may be arranged as follows :—

"1. Seventy-seven plants are common to the three great south temperate masses of land, Tasmania, New Zealand and South America.

"2. Comparatively few of these are universally distributed species, the greater part being peculiar to the south temperate zone.

"There are upwards of 100 genera, sub-genera, or other well marked groups of plants entirely or nearly confined to New Zealand, Australia and extra-tropical South America. These are represented by one or more species in two or more of these countries, and they thus effect a botanical relationship or affinity between them all, which every botanist appreciates.

"4. These three peculiarities are shared by all the islands in the south temperate zone (including even Tristan d'Achuna, though placed so close to Africa), between which islands the transportation of seeds is even more unlikely than between the larger masses of land.

"The plants of the Antarctic islands which are equally natives of New Zealand, Tasmania, and Australia, are almost invariably found only on the lofty mountains of these countries."

The author then points out certain conclusions, to which he was at that time forced by a consideration of the facts involved in the distribution of the plants composing the New Zealand Flora, and proceeds as follows :—

"It was with these conclusions before me, that I was led to speculate on

the possibility of the plants of the Southern Ocean being the remains of a flora that had once spread over a larger and more continuous tract of land than now exists in that ocean ; and that the peculiar Antarctic genera and species may be vestiges of a flora characterized by the predominance of plants which are now scattered throughout the southern islands. An allusion to these speculations was made in the 'Flora Antarctica,' where some circumstances connected with the distribution of the Antarctic islands were dwelt upon, and their resemblance to the summits of a submerged mountain chain was pointed out; but beyond the facts that the general features of the flora favoured such a view, that the difficulties in the way of transport appeared to admit of no other solution, and that there are no limits assignable to the age of the species that would make their creation posterior to such a series of geological changes as should remove the intervening land, there was nothing in the shape of evidence by which my speculation could be supported. I am indebted to the invaluable labours of Lyell and Darwin, for facts that could alone have given countenance to such an hypothesis ; the one showing that the necessary time and elevations and depressions of land need not be denied ; and the other, that such risings and sinkings are in active progress over large portions of the continents and islands of the Southern Hemisphere. It is to the works of Lyell that I must refer for all the necessary data as to influence of climate being dependent on geological change. In the 'Principles of Geology' these laws are proved to be of universal application, and amply illustrated by their being applied to the elucidation of difficult problems in geographical distribution. It follows from what is there shown, that a change in the relative positions of sea and land has occurred to such an extent since the creation of still existing species, that we have no right to assume that the plants and animals of two given areas, however isolated by ocean, may not have migrated over pre-existing land between them. This was illustrated by an examination of the natural history of Sicily (where land-shells, still existing in Italy, and which could not have crossed the Straits of Messina, are found imbedded on the flanks of Etna, high above the sea-level), regarding which Sir Charles Lyell states that most of the plants and animals of that island are older than the mountains, plains, and rivers they now inhabit."

You will, then, observe that although New Zealand presents all the characteristics of, and is properly treated as a distinct province for the purposes of a description and classification of its animal and vegetable life (for the remarks I have quoted in regard to its Flora apply also to its Fauna,) yet it must also be considered as forming a part only of a greatly larger area, within which the Fauna and Flora exhibit such a degree of affinity, as can only be accounted for by the former existence of means of inter-communication, of which all visible traces are now lost. In this connection, for example, it is highly interesting to know that except one or two plants not found in New Zealand, the whole Flora of the Chatham Islands, four hundred miles to the eastward of Banks' Peninsula, is absolutely identical with that of these islands, although some of the forms (as for example, Lomaria discolor, a common fern in our forests) have been somewhat modified in outward appearance, a fact itself of great and striking significance in connection with the views of Mr. Darwin. The same remarks also apply to the Flora of Raoul or Sunday Island, a small island some six or seven hundred miles to the north-east of the northern part of New Zealand, with this increased difficulty in accounting for the general identity between the two Floras (except on the supposition of a former extension of the land of New Zealand, as to include the several islands referred to) that the prevalent winds and the ocean currents between this country and Raoul Island, would drive us to the conclusion, that the former had been colonized from the latter, a supposition opposed to all our present knowledge in regard to the origin and distribution of life.

I will now proceed to offer a few remarks upon the distribution, in its leading characteristics, of the flora and fauna of these islands, which, however, I must do with great briefness, in order not to weary you. But first, let me repeat a remark made in my former lecture, as to the peculiar physical character of the surface of these islands, namely, that they present all the appearance of rugged mountain chains, which originally formed part of an immensely larger area, the greater part of the lower and more level tracts of which have since been submerged. Looked at broadly, in connection with the Flora, and exclusive of alpine and sub-alpine tracts, we may treat the surface of the Islands generally as divisible into bush or forest land, fern land, grass land, and swamp land. I apply the words "swamp land," in the local sense of the term, to tracts usually found near the coasts, and covered with a rich growth of Phormium tenax, and other plants requiring a considerable depth of vegetable soil and much moisture, and by no means in the sense in which the same words would be used in England. Our swampy lands are easily drained, and become very fertile under cultivation, and then yield, in this mild climate, immense and continuous crops of grass. Such tracts generally indicate the site of former forest growth, for, in every instance that I am aware of, at a moderate depth below the surface, large quantities of timber are found. The area occupied by land of this class is not extensive, but it possesses considerable importance in an economical point of view, not merely on account of the fertility of the land itself, but also as yielding a large supply of one of the most valuable fibre plants in the world.

The grass lands occur chiefly, if not exclusively, on the eastern sides of both islands, and now afford pasture to millions of sheep and to great numbers of cattle and horses, thus, in their mere natural condition, adding largely to the wealth of the colony.

Whether these pasture lands were ever covered with forest I very much doubt, although many great naturalists are of opinion, that every part of the surface of the habitable earth, in all climates and regions, was covered with forest growth before it first became the home of man. Nor is enquiry into this question material to the subject under consideration, for it is clear that little, if anything, had been done before these Islands became the abode of civilized man to alter or modify the character or distribution of its vegetation. I have never travelled over the pastoral tracts of the North Island, and am therefore unable to point out what general differences exist (if any do exist) between the grasses there, and those which cover the pastoral lands of the Middle Island. The latter until used as sheep and cattle runs, consisted chiefly of tussock grasses, growing with more or less luxuriance according to the nature of the soil, but presenting only slight differences in character, in their altitudinal range.

When these Islands were first colonized by us, very large tracts were covered with Fern, chiefly "Pteris aquilina." I have little doubt that the greater part of such lands had originally been occupied by forest, destroyed by fire after the occupation of the country by the present native inhabitants. The soil occupied by this growth is usually friable and easily worked, and wherever the fern grew luxuriantly, has turned out valuable for agricultural purposes. The "Bush" or Forest may be roughly divided into three classes, namely, 1st, That which occupies the lower parts of our larger valleys and other low lying tracts near the sea coast,—2nd, That which occupies the upper or higher parts of our valleys, and hills of moderate elevation, within a few miles from the coast line,—and 3rd, That which occupies the greater mass of the mountain districts on the western sides of both islands, up to sub-alpine elevations.

The first class comprises a varied growth, the timber trees belonging, for the most part to certain peculiar genera of Coniferæ, whilst the undergrowth

is usually very luxuriant and dense, more particularly in the deep alluvial deposits at the lower parts of the valleys, where we also find the Laurelia Novæ Zelandiæ and other trees affecting rich moist soils. The small remnant of forest still seen at the entrance of the Hutt valley affords us an example of this class of bush land, and although it is fast being destroyed, it even now gives us an excellent idea of its original variety and density of growth. We still find there living specimens of most of the forest trees, covered with remarkable epiphytes, whilst amongst the undergrowth, the Tree Fern, the Nikau Palm, the Cordyline, and the Freycinetia, and a variety of shrubs delighting in shade and moisture, are closely interlaced with the Supple-jack, the Clematis, and other creeping plants. The second class also comprises a varied growth, but here we find, in addition to forms of Coniferæ occurring in the lower grounds, many species of Metrosideros, Elæocarpus and other timber trees, whilst the undergrowth is also extremely dense and impenetrable, more particularly in the innumerable gullies which have been furrowed in every direction out of the hill sides. Those, however, who can be tempted to explore these dense gullies, are amply repaid for their toil by the extreme beauty and variety of the ferns and mosses with which the ground is carpeted, and the trunks of the trees are covered, whilst the appearance of many of the more gigantic forest trees, is rendered singularly beautiful, by the enormous mass of epiphytes with which they are covered. The third class consists almost exclusively of species of Fagus, with a very sparse undergrowth of Aralia, Coprosma, Rubus, etc. These enormous beech forests will, no doubt, become valuable as the country becomes more thickly peopled, for the timber is well adapted for shipbuilding, and for a large variety of other useful purposes, and the bark yields a considerable quantity of tannin. The great difference in appearance which these Beech forests present, as compared with the other classes of bush to which I have referred, is very striking. As a rule they are open and easily traversed, but the eye becomes fatigued, and the mind oppressed by their monotony, and by the general absence of life which characterises them.

To the North of the Isthmus between Auckland and the head of the Manukau occur extensive forests of kauri, the only true coniferous tree found in these Islands. It does not now occur as a common tree south of the above line, though I am informed that single specimens have been observed as far south as Kawhia; but the bituminous shales associated with some of the coals of Otago, present numerous impressions of forms of Dammara closely allied to the living tree, leading us to the conclusion that the latter is the modified descendant and representative of forms which flourished abundantly during those far distant periods. A fossil gum, chemically undistinguishable from the kauri gum of the north, is also found in the brown coals throughout these Islands, and even in the Chatham Islands, from which we may also infer that these coals are in part derived from altered wood of trees belonging to the same germs, which formed part of the earlier vegetation of that larger area, of which New Zealand is assumed to be only a remnant.

With the Fauna of these Islands I must deal even more sketchily than I have done with the Flora, for, with the exception of its birds, very little has been attempted towards illustrating this branch of their Natural History. The only mammal (exclusive of two or three species of Bat) which was known to be indigenous to these Islands, was the Kiore, or so-called Native rat. It has been the fashion to assume that before the arrival of Europeans in this Colony, this creature was common, and to attribute its destruction to the European rat, and, indeed, the natives have been credited with a proverb in relation to this point. It is not in effect impossible, that the ultimate destruction of those which still existed when trade was first opened between Europeans and the Natives, long after the colonization of New South Wales, may have been

hastened by the introduction of the European rat; but I am satisfied that before that time they had become very scarce, and indeed I have been told by gentlemen who have lived in the northern part of this Island for upwards of forty years, that they never saw a specimen.

The Birds of New Zealand have been collected and investigated by Mr. Walter Buller, who has long promised a more extensive work on the subject, than the pamphlet published in the first volume of our Transactions.

The number of species of land birds is not large in itself, though, as Mr. Buller remarks, the ornithology of these islands does not compare unfavourably in this respect with that of temporate countries in the Northern hemisphere, but although in regard to number of species it may not be important, our birds present many peculiarities interesting to zoologists.

We have, for example, the wingless Apteryx (or Kiwi), the present representative of gigantic races of birds which formerly roamed over our plains and open lands; the Kakapo, or Ground Parrot, inhabiting excavations in the ground, and strictly nocturnal in its habits. Both of these species are confined to our forest-clad ranges, and the latter has not, so far as I am aware, been found in the North Island. We have also, though now very rare, the beautiful Notornis Mantelli, a large Rail, the plumage of which is extremely rich and varied in colour. This bird is known to exist in both islands, but whether the species is in each case strictly identical, I am unable to say. Species of the Wood hen (Ocydromus) are found in both islands, and this bird is still abundant, if not actually increasing in the Middle Island.

Amongst the other land birds more familiar to us are the Kaka or Nestor meridionalis, the Pigeon, the Tui or Parson bird; and several species of small perching birds found in every wood. Many of the New Zealand perching birds are honey-feeders, and, the great majority are insect-feeders. The Kaka feeds largely upon the honey of the phormium tenax, and upon the flowers of the rata. Of ducks there are several species, for example, the Paradise duck (more properly speaking a goose), the Grey duck, the Blue or Mountain duck, and some varieties of Teal. The Paradise duck is a remarkably handsome bird, the female differing completely from the male in plumage.

Of wading birds we have many, amongst others, a magnificent white Crane (Ardea flavirostris), a handsome blue Crane (Ardea matuku), a Bittern (Botaurus poicilopterus), the Pukeko (Porphyrio melanotus), and several smaller birds. The Crane and Bittern are scarce, but the Pukeko is to be found in large numbers in every swamp, and more particularly in those which abut upon cultivations. This bird is indeed more inclined by appetite to cereal grains and plants than to aquatic herbs, and frequents the land more than it does the water. It is handsome and graceful, and active in its movements. It is easily tamed, and mingles readily with ordinary domestic poultry. As these birds are also found in the eastern and southern provinces of Europe, we may accept their presence in this Colony as some indication of the adaptability of our climate to animals, birds, and plants indigenous to mild latitudes.

Of the poultry tribe, except the Pigeon referred to before, I only know the Quail, a delicious eating bird, which, unfortunately, is rapidly disappearing, but which formerly existed on the plains and in all the river valleys in considerable numbers. It has indeed been said that as many as forty brace and upwards sometimes fell to a pair of guns in a single day's shooting.

Of rapacious birds we have several species. A small Hawk, distinguished like its European congener for its daring; a large Kite, and two or three species of Owls. These birds kill vast numbers of rats and mice, and thus more than compensate for the loss of a few chickens and ducklings. I was once told by a German settler that his young chickens, etc., were never

molested by these birds, (although they existed in great numbers in his neighbourhood), when under the charge of a turkey mother.

From noxious reptiles this country is happily free, and we shall scarcely require to import boa constrictors from St. Lucia (as recommended by Sir Charles Darling, to the Acclimatization Society of Victoria), for the purpose of devouring them.

With the indigenous sea fish, and the marine crustacea and testacea we are but little acquainted. The Hapuka, Baracouta, Ling, Snapper, Kawai, and Moki, a species of Flounder, and a few varieties of Rock fish, are the sea fish chiefly obtained and used, and of most of these, as indeed of a large number of the New Zealand sea fish, it may be said, that they are poor in flavour and coarse in flesh, affording a most striking contrast in this respect to the many delicious species found in English waters. There are two species of salt-water Crayfish, both coarse; some excellent Oysters, and a few of the commoner shell fish, such as Mussels, Cockles, Limpets, etc.; but until lately nothing has been done to extend the knowledge obtained by the very earliest colonists in respect to our marine fauna.

Of fresh water fish, we have Eels of several kinds, all extremely good eating; Lampreys, said by the natives to be delicious, and the fry of a fish as yet unascertained, which ascends the rivers in the months of October and November, and is used as whitebait.

In the Province of Nelson, during the month of April, shoals of a small fish from a quarter to half a pound in weight, and of delicious flavour, ascend the rivers, and are then eagerly sought for by epicures, but I am not aware that any attempt has been made to ascertain the ordinary habits of this fish.

Of the invertebrata, we have great numbers, but no great variety, in species of the spider. Moths, and consequently their larvæ, are extremely numerous, and the latter, as well as the larvæ of certain species of beetles, frequently do great damage to the grain and other crops.

There are several varieties of indigenous flesh, and other flies, which are found to be great pests, and they, as well as the imported house and cattle flies, are increasing to an extent which threatens to prove a serious source of damage and discomfort. My own opportunities of observation have been too limited to enable me to point out the checks now in operation to the further and more destructive increase of these insects, but I am convinced that it is of great importance that we should speedily add to the number of those checks, unless we are willing to submit to severe injury and loss. It has been said by a great author, in reference to the injuries which insects can do us, "that the Almighty ordains various instruments for the punishment of offending nations; sometimes he breaks them to pieces with the iron rod of war; at others the elements are let loose against them; earthquakes and floods of fire at his word bring sudden destruction upon them; seasons unfriendly to vegetation threaten them with famine; the blight and mildew realize these threats; and often, the more to manifest and glorify his power, he employs means, at first sight, apparently the most insignificant and inadequate, to effect their ruin; the numerous tribes of insects are his armies, marshalled by him, and by his irresistible commands impelled to the work of destruction; where he directs them, they lay waste the earth, and famine and the pestilence often follow in their train.

"The generality of mankind overlook or disregard these powerful, because minute, dispensers of punishment; seldom considering in how many ways their welfare is affected by them, but the fact is certain, that should it please God to give them a general commission against us, and should he excite them to attack, at the same time, our bodies, our clothing, our houses, our cattle, and the produce of our fields and gardens, we should soon be reduced, in every possible respect,

to a state of extreme wretchedness, the prey of the most filthy and disgusting diseases, divested of a covering, unsheltered, except by caves and dungeons, from the inclemency of the seasons, exposed to all the extremities of want and famine ;" and in the end, as Sir Joseph Banks, speaking on this subject, has well observed, "driven with all the larger animals from the face of the earth." You may smile, perhaps, and think this a highly coloured picture, but you will recollect, I am not stating the mischiefs that insects commonly do, but what they would do, according to all probability, if certain counter-checks, restraining them within due limits had not been put in action; and which they actually do, as you will see, in particular cases, when those counter-checks are diminished or removed.

It might, indeed, be supposed, that the injuries which can be inflicted upon man by insects have often been exaggerated, but our own experience during the last few years completely justifies these ideas. You may, for example, remember the nearly total annihilation of the cabbage, cauliflower, turnip, and other vegetables belonging to the large cruciferæ in the year 1862, caused by an aphis which had not previously appeared in this country. Our apple trees are the prey of another insect of the same kind—the aphis lanifera—commonly called the American blight, which has put a stop to the cultivation of orchards on a large scale. The rapidity with which these creatures increase is something marvellous, though less so when we find that the ordinary laws of generation are suspended in regard to them, the production of young without fecundation, being common to the whole family. Bonnet long ago demonstrated, by a series of most carefully conducted experiments, that at least five generations of the aphis sambuci may succeed each other, the females never pairing. The oak aphis carried this to the ninth generation, and, strange to state, he found that whilst, after pairing, the aphides produced ova, in other cases they produced their young alive. Reaumur computes that each aphis may produce about ninety young, and that in consequence, in five generations the descendants from a single insect would amount to the astonishing number of 5,904,900,000. "Were it not," says Mr. Swainson, "that these immense multitudes are called into being to furnish food for other races, they would be sufficient to destroy vegetation and annihilate the empire of Flora."

Having thus (I am afraid, however, in a very off-hand manner) pointed out to you the leading characteristics and distribution of the Flora and Fauna of these islands, I will now call your attention to what has aptly been termed the "Struggle for Existence" which living organisms of all kinds, are exposed to in a state of nature, and point out in what manner variation lends its aid in protecting both animals and plants from extinction under that struggle. In doing this I shall not hesitate to borrow largely from Mr. Darwin's work. After adverting to the acknowledged variability of organic beings in a state of nature (to which I have called your attention in an earlier part of this lecture) he asks, "How all those exquisite adaptations of one part of the organization to another part, and to the conditions of life, and of one distinct organic being to another, have been perfected? How it is that varieties, (which by the way, he has called 'incipient species'), became ultimately converted into good and distinct species, which, in most cases, obviously differ from each other far more than do the varieties of the same species? How those groups of species which constitute what are called distinct genera, and which differ from each other more than do the species of the same genus, have arisen?" And he proceeds to answer these questions by saying, that the results referred to all follow from the "Struggle for Life," in which all the members of the organic world are engaged. "Owing to this struggle," he observes, "any variation, however slight, and from whatever cause proceeding, if it be in any degree profitable to an individual of any species, in its infinitely complex relations to other organic

beings and to external nature, will tend to the preservation of that individual, and will generally be inherited by its offspring. The offspring, also, will thus have a better chance of surviving, for, of the many individuals of any species which are periodically born, but a small number can survive.

"This struggle for existence inevitably follows from the high rate at which all organic beings tend to increase. Every being which during its natural lifetime produces several eggs or seeds, must suffer destruction during some period of its life, and during some season or occasional year, otherwise, on the principle of geometrical increase, its numbers would quickly become so inordinately great, that no country could support the product. Hence, as more individuals are produced than can possibly survive, there must in every case be a struggle for existence, either one individual with another of the same species, or with individuals of distinct species, or with the physical conditions of life. It is the doctrine of Malthus applied with manifold force to the whole animal and vegetable kingdoms; for in this case there can be no artificial increase of food, and no prudential restraint from marriage. Although some species may be now increasing, more or less rapidly, in numbers, all cannot do so, for the world would not hold them.

"There is no exception to the rule that every organic being naturally increases at so high a rate, that if not destroyed, the earth would soon be covered by the progeny of a single pair. Even slow breeding man has doubled in twenty-five years, and at this rate in a few thousand years there would literally not be standing room for his progeny. Linnæus has calculated that if an annual plant produced only two seeds—and there is no plant so unproductive as this—and their seedlings next year produced two, and so on, then in twenty years there would be a million plants. The elephant is reckoned the slowest breeder of all known animals, and I have taken some pains to estimate its probable minimum rate of natural increase; it will be under the mark to assume that it breeds when thirty years old, and goes on breeding till ninety years old, bringing forth three pair of young in this interval; if this be so, at the end of the fifth century there would be alive fifteen millions of elephants, descended from the first pair.

"But we have better evidence on this subject than mere theoretical calculations, namely, the numerous recorded cases of the astonishingly rapid increase of various animals in a state of nature, when circumstances have been favourable to them during two or three following seasons. Still more striking is the evidence from our domestic animals of many kinds which have run wild in several parts of the world; if the statements of the rate of increase of slow breeding cattle and horses in South America, and latterly in Australia, had not been well authenticated, they would have been incredible. So it is with plants: cases could be given of introduced plants which have become common throughout whole islands in a period of less than ten years. Several of the plants, such as the cardoon and a tall thistle, now most numerous over the wide plains of La Plata, clothing square leagues of surface almost to the exclusion of all other plants, have been introduced from Europe; and there are plants which now range in India, as I hear from Dr. Falconer, from Cape Comorin to the Himalaya, which have been imported from America since its discovery. In such cases, and endless instances could be given, no one supposes that the fertility of these animals or plants has been suddenly and temporarily increased in any sensible degree. The obvious explanation is that the conditions of life have been very favourable, and there has consequently been less destruction of the old and young, and that nearly all the young have been enabled to breed. In such cases the geometrical ratio of increase, the result of which never fails to be surprising, simply explains the extraordinarily rapid increase and wide diffusion of naturalized productions in their new homes.

"In a state of nature almost every plant produces seed, and amongst animals there are very few which do not annually pair. Hence we may confidently assert, that all plants and animals are tending to increase in a geometrical ratio, that all would most rapidly stock every station in which they could any how exist, and that the geometrical tendency to increase must be checked by destruction at some period of life. Our familiarity with the larger domestic animals tends, I think, to mislead us; we see no great destruction falling on them, and we forget that thousands are annually slaughtered for food, and that in a state of nature an equal number would have somehow to be disposed of.

"The only difference between organisms which annually produce eggs or seeds by the thousand, and those which produce extremely few, is, that the slow breeders would require a few more years to people, under favourable conditions, a whole district, let it be ever so large. The condor lays a couple of eggs, and the ostrich a score, and yet in the same country the condor may be the more numerous of the two: the Fulmar petrel lays but one egg, yet it is believed to be the most numerous bird in the world. One fly deposits hundreds of eggs, and another, like the hippobosca, a single one; but this difference does not determine how many individuals of the two species can be supported in a district. A large number of eggs is of some importance to those species which depends on a rapidly fluctuating amount of food, for it allows them rapidly to increase in number. But the real importance of a large number of eggs or seeds is to make up for much destruction at some period of life; and this period in the great majority of cases is an early one. If an animal can in any way protect its own eggs or young, a small number may be produced, and yet the average stock be fully kept up; but if many eggs or young are destroyed, many must be produced, or the species will become extinct. It would suffice to keep up fully the numbers of a tree, which lived on an average for a thousand years, if a single seed were produced once in a thousand years, supposing that this seed were never destroyed, and could be ensured to germinate in a fitting place. So that in all cases, the average number of any animal or plant depends only indirectly on the number of its eggs or seeds."

The author then proceeds to comment upon the causes which check the natural tendency of each species to increase in number, and points out not only the extreme obscurity of these causes, but also that even when at all ascertainable, they are found to be very complex and unexpected. Of this he gives several striking instances, as, for example:—

"In Staffordshire, on the estate of a relation, where I had ample means of investigation, there was a large and extremely barren heath, which had never been touched by the hand of man; but several hundred acres of exactly the same nature had been enclosed twenty-five years previously, and planted with Scotch fir. The change in the native vegetation of the planted part of the heath was most remarkable, more than is generally seen in passing from one quite different soil to another; not only the proportional numbers of the heath plants were wholly changed, but twelve species of plants (not counting grasses and carices) flourished in the plantations, which could not be found on the heath. The effects on the insects must have been still greater, for six insectiverous birds were very common in the plantations, which could not be found on the heath; and the heath was frequented by two or three distinct insectiverous birds. Here we see how potent has been the effect of the introduction of a single tree, nothing whatever else having been done, with the exception that the land had been enclosed, so that cattle could not enter. But how important an element enclosure is, I plainly saw near Farnham, in Surrey. Here there are extensive heaths, with a few clumps of old Scotch firs on the distant hill-tops: within the last ten years large spaces have been enclosed,

and self-sown firs are now springing up in multitudes, so close together that all cannot live. When I ascertained that these young trees had not been sown or planted, I was so much surprised at their numbers that I went to several points of view, whence I could examine hundreds of acres of the unenclosed heath, and literally I could not see a single Scotch fir, except the old planted clumps. But on looking closely between the stems of the heath, I found a multitude of seedlings and little trees, which had been perpetually browsed down by cattle. In one square yard, at a point some hundred yards distant from one of the old clumps, I counted thirty-two little trees; and one of them, with twenty-six rings of growth, had during many years tried to raise its head, and had failed. No wonder that, as soon as the land was enclosed, it became thickly clothed with vigorously growing young firs. Yet the heath was so extremely barren and so extensive, that no one would ever have imagined that cattle would have so closely and effectually searched it for food.

"Here we see that cattle absolutely determined the existence of the Scotch fir in this particular locality and under the conditions indicated; but in several parts of the world insects determine the existence of cattle. Perhaps Paraguay offers the most curious instance of this; for here neither horses, nor cattle, nor dogs, have ever run wild, though they swarm northward and southward in a feral state; and Azara and Rengger have shown that this is caused by the great number in Paraguay of a certain fly, which lays its eggs in the navels of these animals when first born. The increase of these flies, numerous as they are, must be habitually checked by some means, probably by birds. Hence, if certain insectivorous birds (whose numbers are probably regulated by hawks or beasts of prey) were to increase in Paraguay, the flies would decrease—then cattle and horses would become feral, and this would certainly greatly alter (as indeed I have observed in parts of South America) the vegetation; this again would largely affect the insects; and this, as we have just seen in Staffordshire, the insectivorous birds, and so onwards in ever increasing circles of complexity. We began this series by insectivorous birds, and we have ended with them. Not that in nature the relations can ever be as simple as this. Battle within battle must ever be recurring with varying success; and yet in the long run the forces are so nicely balanced, that the face of nature remains uniform for long periods of time, though assuredly the merest trifle would often give the victory to one organic being over another, nevertheless so profound is our ignorance, and so high our presumption, that we marvel when we hear of the extinction of an organic being; and as we do not see the cause, we invoke cataclysms to desolate the world, or invent laws on the duration of the forms of life!" The same author further adds:—

"I am tempted to give one more instance showing how plants and animals, most remote in the scale of nature, are bound together by a web of complex relations. I shall hereafter have occasion to show that the exotic Lobelia fulgens, in this part of England, is never visited by insects, and consequently, from its peculiar structure, never can set a seed. Many of our orchidaceous plants absolutely require the visit of moths to remove their pollen-masses, and thus to fertilize them. I have, also, reason to believe that humble-bees are indispensable to the fertilization of the heartsease (Viola tricolor), for other bees do not visit this flower. From experiments which I have lately tried, I have found that the visits of bees are necessary for the fertilization of some kinds of clover; but humble-bees alone visit the red clover (Trifolium pratense), as other bees cannot reach the nectar. Hence I have very little doubt, that if the whole genus of humble-bees became extinct or very rare in England, the heartsease and red clover would become very rare, or wholly disappear. The number of humble-bees in any district depends in a great degree on the number of field mice, which destroy their combs and nests; and Mr. H. Newman, who has

long attended to the habits of humble-bees, believes that 'more than two-thirds of them are thus destroyed all over England.' Now the number of mice is largely dependent, as every one knows, on the number of cats; and Mr. Newman says, 'Near villages and small towns I have found the nests of humble-bees more numerous than elsewhere, which I attribute to the number of cats that destroy the mice.' Hence it is quite credible that the presence of a feline animal in large numbers in a district might determine, through the intervention first of mice, and then of bees, the frequency of certain flowers in that district!"

In summing up the results of his enquiries, Mr. Darwin has applied the term "Natural selection" to the principle or operative agency, which the foregoing extracts are intended to illustrate, viz., that principle under which slight variations in any species tend, if useful, to be accumulated and to be preserved to succeeding generations. The term "Natural selection" was adopted by Mr. Darwin in order to mark the relation of the principle or agency in question, to the power which man exercises over domestic animals, for, as you are aware, man by taking advantage of variations in character amongst domesticated animals has been able to produce a large number of breeds and varieties, more or less useful to himself. It must not, however, be supposed that nature operates as rapidly or necessarily in the same direction as man in assimilating such variations.

"Man," says Mr. Darwin in his work on "Animals and Plants under Domestication," "selects varying individuals, sows their seeds, and again selects their varying offspring. He may be said to be trying an experiment on a gigantic scale, but the initial variation on which he works, and without which he can do nothing, is caused by slight changes in the conditions of life which must often have occurred under nature. The experiment which man has been making is one which nature, during the long lapse of time, has incessantly tried."

To sum up again: I have now briefly shown you — by reviewing the investigations of modern writers on such subjects, and chiefly those of Hooker, Lindley, Darwin, Lyell, and Marsh, — the divisions and subdivisions of the organic world; the laws which regulate the geographical distribution of plants and animals; the tendency to vary which characterises living organisms; the principles under which any variation, however slight, and from whatever cause proceeding, if it be profitable, tends to the preservation of the individual; the transmissibility of acquired variations in character; and the struggle for existence which all life is engaged in.

And I have also shortly called your attention to the distribution, affinities, and general characteristics of the Flora and Fauna of these Islands—sketchily it is true—but sufficiently for the purposes of my further observations, if, as I have a right to suppose, you have made any reasonable use of the opportunities you enjoy in common with myself, of acquiring more detailed knowledge in regard to them.

It was my intention originally to have dealt with the whole of my subject in this lecture, but I have found it impossible to do so, and I am compelled to defer to a future occasion a consideration of the position, (relatively to the questions discussed in this and in my last lecture), in which our Flora and Fauna stood immediately before the systematic colonization of these islands, and the effects already produced, and likely to follow, from the introduction of competing foreign organisms. This, of course, I can only do broadly and briefly, but I hope to satisfy you, that the operations now going on are calculated to produce all the results which I have suggested as probable in the future.

ON CERTAIN MODERN PROJECTS OF INTER-COMMUNICATION, AND THEIR RELATION TO NEW ZEALAND. By F. WAKEFIELD, F.L.S.

[Lecture delivered at the Colonial Museum, Wellington, September 4, 1869.]

THERE never was a time in the history of the world when such vast schemes were in progress or projected for the extension of rapid and easy communication between different parts of the earth; indeed, it appears to be the feature of the age, that nations, in whatever else they should differ, would cordially agree in forwarding every plan having for its object the shortening of time and space, and lowering the cost of transit between the most distant points of the globe; and from what has taken place, it may be safely affirmed that the results will far exceed even the dreams of the first inventors of the means employed.

Electricity and steam communication appear as the appointed agents of an All-wise Providence for building up the comity of nations;—for obliterating prejudices and antipathies;—for throwing down restrictions upon free intercourse in trade, science, literature, and all the generous amenities that should bind man to man.

As the liquid fire flies along the metal carrying with it the thoughts of men; or as travellers stretch across whole continents in a few days, one language will have to be adopted; the gibberish of the savage will die out before a flexible and more polished form of expression; money must bear one sovereign effigy; bad forms of government will be so keenly felt and discussed that they must give way to better; and the result will be a state of freedom and healthy progress unknown in the history of mankind. Nor is it too much to suppose that as the future of America will see one language spoken from Canada to Cape Horn; and our government of India and England's other dependencies will be made so attractive that our fellow-subjects will be numbered by hundreds of millions, "the well of English undefiled" will be the source from whence the common language of the line and rail will be drawn. The magnificent store of literature, which is the noble heritage and common property of all who speak the English language, will keep the peace, whilst the extended comfort and well-being of mankind are our common object; for should discord arise between us, the pioneers of the world's civilization, the historians, geographers, men of science, poets and orators, on each side of the Atlantic, cherishing a common idiom as their mother tongue, with Shakespeare as Marshal of the Lists, would forbid so unnatural a contention. No better instance could be adduced of the influence I fondly hope to see prevail than the appointment of a genial man of letters, like Motley, as American Minister at the Court of St. James', who is more likely to settle the Alabama claims than the most practised diplomatist, for all England enjoys his writings.

Taking England as one centre, and our Southern England, New Zealand, as the other, upon the earth's surface, the projects in progress or under consideration may be classed as follows:—

I. WEST OF ENGLAND.

The Ocean Steam Navigation Companies connecting England with America.

The Atlantic Cable connecting Ireland with Boston, and other cables being laid.

The Panama Railroad, connecting the Atlantic and Pacific oceans.

Canadian Canals and the St Lawrence, connecting Chicago and the Lakes with London.

The Pacific Railway, connecting New York with San Francisco.

II. East of England.

The Indian Telegraph by Constantinople to Bombay.

The Overland Route by Peninsular and Oriental Company's Steam vessels through Egypt to Galle, China, Japan, and Australasia.

The Maritime Canal of Suez.

The Messageries Imperiales, a company subsidized by France on the same line as that worked by the Peninsular and Oriental Company.

The proposed Overland Route to India, from Belgrade to Constantinople, and Bussorah to Kurrachee.

The line of large ocean steamers by the Cape of Good Hope to Melbourne.

III. West of New Zealand.

The steam navigation companies connecting us with Melbourne, and the P. and O. Company to England.

Telegraphic communication from South Australia to Brisbane.

The line of cable laid between Victoria and Tasmania.

IV. East of New Zealand.

The probable extension of a line of steamers from San Francisco to the Sandwich Islands, Tahiti, New Zealand, and Sydney.

Every one of these projects having for its object the increase of rapid, cheap, and convenient communication, is of great importance to us, possessing as we do, taking it for all in all, one of the best fields for emigration in the world.

Our goldfields can only enrich the country by attracting population; for no country was ever great or prosperous through its mines of gold and silver alone. Our unoccupied millions of acres are of no more value than so much cloud or sea, without population to reclaim them from the waste; and the accounts one reads in the English papers of the masses of people receiving public relief are the more painful to peruse, when at our own doors there is bread for all. Therefore, a cheap, humane, and well-regulated system of immigration would be a mutual benefit to England and ourselves; and every project similar to those I have enumerated, is a step in the right direction.

Out of the different plans either completed, in progress or under consideration, I have selected three, the particulars of which I have endeavoured to put together as clearly and briefly as I could, and trust that the subjects will prove worthy of your attention:—

I. The Maritime Canal of Suez.
II. The proposed Overland Routes to India.
III. The Atlantic and Pacific Railroad, connecting New York and San Francisco.

The Maritime Canal of Suez.

Before the Cape of Good Hope was doubled, nearly 400 years ago, and a new sea-way found to India, the trade of the East being principally carried on by caravans, a canal through the Isthmus of Suez, connecting the Red Sea with the Mediterranean, was not so important to the whole world, as an improved civilization, a vastly increased population, and a far-extended commerce render it in our own time. Yet this modern project is not without ancient example, though with a less object, on part of the same land.

About the middle of the seventh century before the Christian era, according to Herodotus, a line of canal for fresh water was commenced at Rhoda on the Nile, near the modern Cairo, and continued by the margin of the extreme eastern desert to Bubastis—thence by the Wadi Tombat, or Valley of the Seven Wells, skirting the Bitter Lakes—it reached Suez, which was then known as Clysma. It was commenced by Necho, son of Psammetichus, and completed by Darius, the son of Hystaspes. A period of one hundred years was occupied in the work, and 120,000 Egyptians perished in the labour, which was so hard, that an oracle admonished the taskmasters to desist, and for a time it ceased. The remains of this work are still to be seen; but I am not aware—though I have made diligent search amongst the authorities—that an attempt was ever made in ancient times to connect the two seas by means of a canal. The wants of the day, 2400 years ago, were met by the river Nile, 180 miles from the sea to Rhoda, and 105 miles of fresh water canal to the Red Sea.

A good deal may have been due to French influence in the East that the maritime canal at Suez has become a great public question, but I still think that the project by an English engineer, Mr. Lionel Gisborne, of cutting through the Isthmus of Darien, in 1852, brought the subject of removing such obstacles to navigation more prominently before the world; and many think that it will always be a matter of regret that Mr. Gisborne's plan was not taken up by the merchants of Europe and America. Though Mr. Gisborne was not permitted to live to carry out his plan, his labours were not thrown away, and the facts which I have gathered from his report are curious. He found that the tide on the Pacific side of the Isthmus of Darien rose twenty-three feet, whilst on the Atlantic side it was scarcely appreciable—that at mid-tide the two oceans would be nearly level, and that therefore the ebb and flow of the Pacific would cause a current both ways, not exceeding a rate of three miles an hour, acting as a scour to prevent deposit, and an assistance in the transit of vessels. This would also secure the passage being effected in one tide, and prevent the passing of vessels going different ways, as the direction of the trade would be alone influenced by the ebb and flow of the Pacific tide. Mr. Gisborne also found that the material to be excavated would be chiefly rock, so that the current or the wash of passing steamers would not tear away the banks, thus reducing the cost of maintenance to a nominal sum. The canal was to be 30 feet deep at low water, 140 feet wide at bottom, widening to 160 feet at low-water surface. The rivers Savana and Lara were to be made use of for eighteen miles on the Darien side, leaving the actual breadth of the Isthmus between the tidal effect of the two oceans at thirty miles. The summit level of this lowest ridge of the Andes was found not to exceed 150 feet, formed by a narrow range of hills, having a gradually rising plain on each side. The report does not state if any prevailing winds were likely to render the two entrances periodically unsafe, so I presume that the canal would have been always easy of access and egress.

Messrs. Fox and Henderson, the contractors for the great Exhibition Building in 1851, employed Mr. Gisborne, and the position they held enabled them to make that gentleman's report well-known throughout the world, particularly as they were to get up the company for the performance of the work.

There can be but little doubt, as the above information became public, that Monsieur de Lesseps, in inaugurating his plan of making a canal through the Isthmus of Suez, and before he finally enlisted the late Ismail Pasha, then Viceroy of Egypt, heartily in the project, in 1854, made himself certain as to the relative height of the water at the same time in the Red Sea and the Mediterranean, where he intended to connect their waters by an open cutting without locks. Unfortunately an opinion of weight had gone forth that pre-

vailed for nearly fifty years, being the result of an investigation ordered by Napoleon when in Egypt in 1798. His chief civil engineer was ordered to report upon the practicability of a canal between the two seas; and the only result was an apparent difference of thirty-two feet between the level of the Red Sea and the Mediterranean. But, in 1846, a tripartite commission was set at work to study the relative levels and tidal amplitudes of the two seas and the Nile. In this commission Mr. Robert Stephenson represented England; France sent M. Talabot; and the Chevalier Negrelli acted for Austria. The result showed that the difference in the levels of the two seas was so slight as to be of no practical account.

Thus a great difficulty was removed in making an accurate calculation for a work of such vast magnitude, as it was now made clear that if the 100 miles of intervening land were intersected by an open channel of moderate width and depth, the waters of the two seas would meet without the aid of locks or any other artificial arrangement.

At the first sight of the map of Europe, the Mediterranean would appear to be higher than the Red Sea, because the former, confined as it is at its mouth, being scarcely nine miles in width between Ceuta and Gibraltar, is only the last of a chain of lakes of which the Sea of Azof, fed by the River Don, is the first. The current is strong into the Black Sea at the Straits of Yenikale, near Kertch, and still more rapid where the Black Sea flows through the Bosphorus, a distance of eighteen miles into the Sea of Marmora. There is also a strong current through the narrow passage of the Dardanelles from the Sea of Marmora into the Mediterranean. Besides this absolute fall, the waters of the Danube, the Nile, the Po, and the Rhone are received into the Mediterranean; and as the swell of the Atlantic at Gibraltar is always inwards, from the prevailing westerly winds, a head of water might be supposed to exist, that a canal through the Isthmus of Suez would, as it were, tap and let into the Red Sea. If this were the case, a current would be created useful for the passage of ships going to the eastward, but likely to damage the banks of the canal, excavated for half its length in the sand of the desert.

Again, the Red Sea, being an arm of the Indian Ocean, 1200 miles long, confined at its entrance by the Straits of Bab-el-Mandeb, or the Gate of Tears (so called by the Arabs from the frequency of shipwrecks in taking shelter from the storms of the Indian Ocean), and the Island of Perim, would have its tides disturbed from its narrowness, from the rapid growth of coral reefs, and from the prevalence of the north-west wind, nine months out of the twelve, that would keep back the water. But all this, as we shall see, however ingenious in speculation, is not the case; for the fact has been settled, to a demonstration, that the waters of the two seas are almost level; and that the mass of water removed by evaporation under the almost constant hot sun in those parallels of latitude accounts for a fact which would otherwise appear inexplicable.

The suggestion of the modern maritime Suez Canal is due to Ferdinand de Lesseps, a man of the most indomitable perseverance and energy, with a most suggestive mind, who has had to contend, and almost alone, with difficulties that would have overwhelmed men not made after the fashion of Christopher Columbus. England's jealousy of France was the first obstacle; and when that was disposed of, engineering jealousies began, and these effectually retarded M. de Lesseps' object—the forming of a company with whose funds the work might be commenced. Yet after almost as many years waiting as Columbus passed in soliciting the slender means from his Sovereign to add a new world to the Spanish Crown, M. de Lesseps has triumphed over all; and whether the canal ever pays or not, his name will always be connected with one of the greatest public works ever attempted, contrived, begun, and watched to its completion by the mind of one man.

The capital of the company is in round numbers, sixteen millions sterling. The canal, with its ports at each end, was to be the property of the company for ninety-nine years, after which it would belong to the Egyptian Government, who, in the meantime, was to receive 15 per cent. of the traffic earnings. The tolls charged for passage were always to be equal for ships of all nations; and, I think, at about the rate of £30 sterling for a vessel of 500 tons from sea to sea.

The Maritime Canal extends from the newly-constructed artificial harbour of Port Said on the Pelusian Coast of the Mediterranean, about midway between Alexandria and Joppa, the port of Jerusalem, to the port of Suez at the head of the Red Sea. The length of the canal is not quite 100 miles. Its depth throughout is 26 feet; its general width is 246 feet at the base, and 328 feet at the top of the banks, except where in some places on the line it has to be cut through high ground, there the width is reduced to 190 feet at the lower part. There will be no locks in the Maritime Canal, and vessels will be able to steam through, or be towed through, in about sixteen hours from sea to sea.

The ancient Pelusium was selected for the Mediterranean entrance to the canal, because at that spot, 2870 yards from the shore, there was a depth of 30 feet of water. This is now called Port Said. There a harbour has been formed by running out into the sea two breakwaters or moles, which are formed of huge blocks of concrete. Each block measures twelve cubic yards, weighs twenty-two tons, and is composed of two-thirds sand and one-third hydraulic lime. The lime is imported from France, the sand is dredged up in the harbour, and each block costs £13 sterling. They are not laid in as masonry, but thrown down loosely, and are intended to answer the double purpose of protecting vessels from heavy seas, and of arresting the alluvium brought down by the River Nile in its passage towards the Bay of Pelusus, so as to prevent its choking up the channel. The western breakwater extends from the shore 2400 yards in a straight line, N.N.E.; and then with a slight angle towards the east extends 330 yards further. The eastern breakwater leaves the shore at a point 1530 yards to the eastward of the commencement of the western one, and extends nearly north for a distance of 2070 yards, at which point it is 760 yards from the western breakwater, and this distance constitutes the width of the entrance. The portion of the harbour affording shelter to vessels is nearly 500 acres in extent; and although the depth of water is not sufficient for the largest men-of-war, it is quite sufficient for ordinary merchantmen, if the present depth be maintained. The prevailing winds being from the north-west, large quantities of mud are constantly brought along the shore from the Nile; and this has been one of the main objections to the probable success of M. Lesseps' scheme.

Whilst at this point, with the map of the world before us, might I be allowed to point out why the Nile, after leaving upon all the soil of Egypt that is affected by the annual inundation, a sufficient coating of mud to render the country proverbially the most fertile in the world, can yet discharge a torrent of mud by its two mouths likely to endanger the success of a harbour 50 miles to the eastward of where the Nile meets the sea. Now that we know from Baker, Speke, Grant and others, that the Bahr al Abiad, or White Nile, has such a slight inclination from the Lake Victoria Nyanza, that if there were any deposit in the overflow of the lake, it could not proceed far; it is no longer a matter of speculation from whence the Nile proper receives the alluvium with which its waters are charged during the inundation every July, August, and September. It comes from the Bahr al Azreck, or Blue Nile, which is swollen to a resistless torrent as it rushes from the mountains of Abyssinia during the rainy season, bringing with it the rich humus formed from

the yearly decaying leaves of a rank tropical vegetation. The Blue Nile enters the Nile proper at Khartoum; and though the White Nile contributes a much larger quantity of water than the Blue tributary, it only dilutes the mud and gives the whole body of the river force to reach the sea. The quantity must be enormous; for being discharged by two mouths, a larger volume of muddy water reaches the sea than if the discharge were effected by seven small ones as in ancient times. Since visiting Egypt, and reading all I could upon the subject, I am quite confirmed in the opinion that the river finding the seven small mouths insufficient, formed the two present ones as the only means of ridding itself of the wall of water coming from the South. And, again, when Egypt was governed by enlightened and beneficent monarchs, millions of acres which are now desert swarmed with people making the most of every drop of the inundation, and thus retaining perhaps all the alluvium to fertilize the land, that is now annually discharged into the sea, and threatens to block up the harbour of Port Said.

On leaving Port Said, the canal enters Lake Menzaleh, through which the channel is excavated for 29 miles to Kantara, a station on the desert route of the caravans from Cairo to Syria. The course of the canal then lies through low sand-hills to Lake Ballah, which it traverses for a distance of 8 miles, and then enters a deep cutting extending from El Ferdane to Lake Timsah. Near El Guisr, 4 miles south of El Ferdane, the deepest cutting throughout the whole line occurs, and it had to be excavated varying from 60 feet to 70 feet in depth.

The characteristics of the first half of the maritime canal are, that about 34 miles of the course lie through lakes, and the remainder through elevated plateaux and low sand hills.

The town of Ismailia has been founded on the northern side of Lake Timsah.

The second half of the canal divides into two portions: in the first the canal skirts the eastern shore of Lake Timsah, and enters the cuttings at Toussoum and Serapeum; in the second, on emerging from the Serapeum cutting, the canal pursues a central course through the Bitter Lakes for 24 miles, going through the last cutting at Chalouf, and enters the Red Sea a mile to the south-east of Suez, the last twelve miles to the Red Sea being through a continuous level plain slightly above the level of the sea.

The fresh water of the Nile is brought by a canal to Ismailia from Cairo and thence to Suez, which used to be wretchedly supplied with water, giving the administration of the canal the power of growing anything under such a sun.

The question of tolls can only be decided when the canal is fairly opened, for it is questionable if any vessels without at least auxiliary steam power could take advantage of the Suez Canal, on account of the baffling winds in the Mediterranean and the Red Sea, as by this line all the advantages of the trade winds, the monsoons, and great circle sailing must be lost.

The three objections urged by the late Robert Stephenson, after walking twice over the whole ground, and thoroughly examining the project, are still in the opinion of most practical men as patent as ever. These were—

1. The difficulty of keeping the entrance open at Port Said, for two reasons, the first of which was the shallowness of the sea for a long distance from the shore; the second was the constant flow of the sea, driven by the almost continual N.W. wind from west to east, carrying with it the mud of the Nile, from its two mouths at Damietta and Rosetta. This objection M. de Lesseps proposed to obviate in his first plan by making the piers or breakwaters six miles long. Mr. Stephenson still objected that the flow of the water heavily charged with mud would soon render the sea so shallow on the

western side of the piers, that they would have to be lengthened beyond the money power of any company to support.

2. The wash of passing steamers and the force of the wind would wear away the sides, and involve the expense of lining the bank with worked stone, while the nearest place from whence it could be obtained would be Cyprus. This expense would ruin any company however rich.

3. The sand of the desert raised by the high wind would be deposited in the canal, and a constant expense of dredging to keep the channel open would again tax the resources of the company to the utmost.

An engineer, a Mr. Fowler, has lately been sent to examine the whole project, and he already recommends the large blocks of stone that M. Lesseps has thrown loosely into the sea to form the western breakwater, to be laid solid to prevent the Nile mud from choking up the channel between the two piers. Powerful dredges are also at work keeping that part of the canal open most likely to be obstructed by the drifting sand; and lastly, the practice of other canals where steam power is used as a means of traction, is in favour of Mr. Stephenson's objection that the wash of passing vessels will degrade the banks and cause endless expense in lining them with stone.

It is my sincere desire that the Suez Canal may yet come up to the most confident hopes of its projectors; for if it answered it would benefit the whole world: but I cannot set my doubts at rest, however much I may wish it to succeed, when I consider the disadvantages under which nature has placed that part of the earth for successfully carrying out such an undertaking.

The Overland Routes to India.

There have been several routes to India proposed within the last thirty years, partly by land and partly by sea, arising from the greatly increasing importance of the trade between Europe and the East; but more particularly from the rapidly developed system of railways which now brings every part of India within an easy distance of London.

The first was the present route through Egypt, proposed by Lord Ellenborough, when Governor-General of India, and carried out, against much opposition, by Lieut. Waghorn in 1845.

The second was the line proposed by Colonel Chesney, from the Bay of Iskanderoon, due east 100 miles to Bir on the Euphrates, and thence by that river to Bussorah, in 1850.

The third was that proposed by Sir Macdonald Stephenson in his pamphlet called "The World's Highway," in 1857. I had a good opportunity of knowing his views upon the subject when employed by him in Asia Minor; and but for the Ministry of the day being displaced who supported the plan, I was named to organize a party to explore the line in its whole length. The proposed line was to start from Belgrade on the Danube, which even at that time was connected with Vienna and the rest of Europe. It was to run from Belgrade to Constantinople through a pass in the Balkan, by Philipolis and Adrianople, a distance of 500 miles, thus making it possible when the line should be properly organized to reach Constantinople in sixty hours from London. The line was to cross the Bosphorous about four miles above Constantinople from the Castles of Europe to the Castles of Asia; and from thence to Bussorah at the head of the Persian Gulf, a distance of 1400 miles. In this 1900 miles there was comparatively speaking no engineering difficulty to be contended with to be compared with those of the Pyrenees on the line connecting Spain and Portugal with France. The first 200 miles through Asia Minor, would cross the elevated plateau of Phrygia near Lake Van, and descend upon the great Assyrian plain watered by the Tigris and Euphrates. From Bussorah the course was to lie along the coast of Persia and Belloochistan

to Kurrachee, and on to Lahore, a distance of 1500 miles. Of course, the longest and last part of the line was anything but plain sailing. Some arrangement was proposed to be made with the government of Persia, by which an armed party could proceed with safety from Bussorah to the Indus; but Sir Macdonald Stephenson depended more than anything upon the material advantages conferred upon the country by a well-managed railroad from Belgrade, than on all the diplomacy in the world, even in a country governed by Turks. New ideas would penetrate where a somnolent despotism has prevailed for ages. Fertile land for hundreds of miles would be reclaimed from the waste, and the blessings of a popular government would be sure to follow the material improvement of the country. It was to this that he looked as a means of getting over the danger arising from the wild tribes inhabiting the countries between Bussorah and Scinde; and in support of what I say I could not cite a more apposite instance than that of Hungary at the present hour. That country was prepared for a perfectly free government through Count Secheyny devoting his useful life to the introduction of roads and steam boats on the Danube; as by these appliances the production of the country was greatly stimulated; the comfort of the people was increased; and the confines of the Austrian Dominions were brought in contact with Pesth and Vienna, by which a public opinion was created that has saved the Empire.

The result of this third line was to bring Lahore within a fortnight of London; and the whole strength of Sir Macdonald's argument lay in the superiority of rail over sea passage, or in other words, of forty or fifty miles over ten or fifteen miles an hour.

From the information received from the best possible sources at that time, I am not aware that there is a serious engineering difficulty between Calais and the Indus; and I therefore look upon the adoption of this line as perfectly certain if once Belgrade and Bussorah are connected by rail.

The last line lately proposed was to start from Hamburgh to Warsaw, and thence to Odessa, Poti on the Black Sea to Tiflis and Teheran. But I cannot see the advantage of a more northerly line through a worse climate, and through the defiles of the Caucasus, because it is straighter. Constantinople is made by nature as the centre of trade with the East. Within the same area there is no spot in the world which commands so easy a communication with the most productive parts of the earth, both by sea and land, and any line of telegraph or railroad that avoids the Bosphorus throws away the most remunerative portion of the road between Europe and India.

The Pacific Railway.

The origin of the Pacific Railway may be traced to the increase of territory by the United States at the close of the war with Mexico, and the finding of gold in California rather more than twenty years ago.

By an Act of Congress, passed in March, 1853, the War Department was directed to ascertain the most practicable and economical route for a railroad from the Mississippi to the Pacific Ocean. Mr. Jefferson Davis was then Secretary at War, and the results of the explorations and surveys made under his directions between 1854 and 1857, are comprised in the eleven volumes of Pacific Railway Reports, which are as well known to botanists, naturalists, and geologists, as to geographers and engineers.

Five different lines were surveyed and reported upon, Mr. Davis deciding upon that marked red upon the map, and strongly recommended its adoption by Congress. But between 1853 and 1860 the political horizon gradually assumed a lowering aspect. The pro-slavery question being defeated in the West, with Southern influence paramount at Washington, civil war followed as a direct consequence; and the almost matured project of constructing a

Southern Pacific Railroad by the thirty-second parallel of latitude fell through as a matter of course.

In 1862, the isolated position of the Pacific States was keenly felt by statesmen at Washington, and the question was first mooted that California and her neighbours might waver in their loyalty to the Union. An iron-road should bind them to New York, and the question of a through Pacific Railroad again came prominently before Congress.

In the meantime the production of gold in California had been enormous; corn was raised far in excess of the local demand; Southern California was striving to export wine, hides, and tallow; trade had sprung up with Oregon, the Sandwich Islands, and most important of all with China; quicksilver was almost flowing from the mines of Almaden; and the strong desire felt by the Californians for a Pacific railroad was brought to a climax by the discovery that a practicable route across the snow-clad Sierra did exist through Donner Pass, midway between San Francisco and Virginia City. Nevada gave a helping hand to California by the discovery of the Comstock silver mine, and the wealth that poured in from it, raised that territory into the Council of the States.

Even amidst the horrors of civil war, when Washington itself was threatened, and £500,000 were leaving the Treasury daily for the support of the northern armies, still the Pacific Railroad Bill was triumphantly carried, and grants of land and subsidies were agreed upon, increasing in amount as the line advanced westward; but no definite conclusion was arrived at as to the Eastern starting point of the route. The great precedent was however established—that government aid to the extent of about half the total amount necessary would be provided out of the national treasury to assist a Pacific Railway enterprise. Finally, the following programme was adopted, and the work actually commenced: the main line was to extend from Omaha on the Missouri river, to Sacramento in California, 1721 miles. St. Louis was to be provided for by a subsidised branch line to connect with the main line on or about the hundredth meridian of longitude, east of the Rocky Mountains.

Three companies were to prosecute these works, and to stand on an equal footing as regards land grants, loans, etc. Firstly, the Union Pacific Railway Company constructing the line westward from Omaha. Secondly, the Central Pacific Railway of California proceeding eastward from Sacramento. These companies were to make their lines as quickly as possible from either end, and to meet at an intermediate point not fixed. Thus it was the interest of each company to lay as much track as possible, for the amount of Government subsidy, as well as the share of influence in the management, depended on the proportion of the line laid. Immense parliamentary excitement took place, and the contest was between St. Louis and Chicago. Money was spent like water, in the Legislature, but not under its ordinary name, being called by an American journal of the period, "the element of influence." Thirdly, the Union Pacific Railway Company, Eastern Division, obtained the Government subsidy for a distance of 400 miles west of Kansas city. Thus it is evident that Chicago had gained the day.

If the civil war had not intervened, it is more than probable that, although the year 1869 might not have seen a locomotive plying between New York and the Pacific, we should never have seen the iron road laid across the Black Hills. Chicago would have built the branch line, and the main line would have been laid further South, below the barrier of winter snows; it would have passed round the Rocky Mountains, not over them; across productive valleys, instead of through worthless deserts, and along the rich central trough of California, in the place of climbing an Alpine pass more than 7000 feet above the Pacific.

The chief clauses of the Government grant are these, and worthy of notice in the future of New Zealand:—Congress confers upon the three companies mentioned the right of way through all their territories; an absolute grant of 12,800 acres per mile of the public lands through which the lines run, i.e., alternate sections of one by twenty miles on each side of the line; the right to use the coal, iron, timber, etc., thereon; and authorises a special issue of United States bonds bearing 6 per cent. interest, proportionate in amount to the length and difficulty of the lines, to be delivered to the companies as the works progress, and as short sections of the road (usually twenty miles in length) are passed by the Government inspector. The cost of the railroad west of Chicago, a distance of 2000 miles, may be said to have amounted in round numbers to £35,000,000 sterling, besides the 14,080,000 acres of land lying contiguous to the line in its whole length, worth six millions more.

The description of the whole line would perhaps be tedious; but there is one portion of it, 721 miles long, that is worthy of attention. This is the inland or great basin region of North America, extending from the dividing ridge of the Wahsatch mountains to the summit of the Sierra Nevada. It is a vast desert considerably larger than France, covered with short volcanic mountain ranges; it possesses a fertile soil, but suffers from an insufficient rainfall; none of its scanty streams enter the sea, but each discharges its waters into a little lake, and remains shut up within its own independent basin. Rich silver mines are being discovered year by year all over the basin region, and the yield from them already equals in value that of the goldfields of California.

The difficulties of the construction of such a railroad can only be imagined by those who have never seen a similar country. The Central Pacific Railway, starting from Sacramento, fifty-six feet above the level of the sea, reaches the summit of a mountain ridge exceeding 7000 feet in height, in 105 miles. Here the engineering difficulties of the line centre.

Most of the heavy grading averages 95 feet per mile; but for only three and a half miles is 116 feet (or what in England we should call 45½ to 1), the maximum grade allowed by Congress, resorted to.

There are thirteen short tunnels, the longest being 1700 feet in length. It is a very hard strain upon two powerful engines to drag ten passenger cars with luggage up so steep an ascent, and the carriage of heavy freight is necessarily costly. During the whole of the summer of 1868, 3000 teams and 10,000 Chinamen were employed to grade and lay the track across the basin region. During the previous winter long lines of sledges were used for transporting iron rails and ties across the summit to the valleys of the Truckee and the Humboldt. When the snow had sufficiently thawed to allow of the tunnels being completed, an average of 500 tons of ties, spikes, bolts, and chairs, were carried over the Sierra in fifty cars, drawn by ten locomotives every day, and were sent from 300 to 400 miles to the scene of operations. Here two miles, and sometimes more, were laid in a day, each two miles requiring 500 tons of materials for their construction. The rails used weighed from fifty-six to sixty-four pounds per yard.

For thirty miles across the mountain the snows of winter appeared insurmountable; but by the 1st of January in this year the Californians had roofed in twenty miles with strong wooden sheds wherever the snow was likely to impede the traffic.

During 1868, 866 miles were added to the railway by the united companies, being an average of two and two-thirds of a mile a day, Sunday excepted. In the history of railway construction this rapidity has no precedent; and when it is remembered that for 1600 miles, wood for ties could only be obtained at three points accessible to the road, and that the country is mostly an uninhabited desert, the result appears still more marvellous.

Whilst abundance of coal sufficiently good for locomotives has been found in several localities near the railroad, none has been found between the Great Salt Lake and the Pacific coast.

To enumerate the subjects of great interest connected with this marvellous undertaking, would occupy more time than can now be spared. Suffice it to say that the net of railways, to which the Pacific railroad will be a backbone, may have considerable influence on New Zealand. By the railroad London could be reached from Wellington in thirty-seven days; as San Francisco is 600 miles nearer Wellington than Wellington to Panama: thus, London to New York, ten days; New York to San Francisco, six days; San Francisco to Wellington, twenty-one days. It is but a question of time when our mails will be carried along that line. The cost, first-class from New York to San Francisco, is £28 sterling.

I beg leave to close this brief account of the Pacific railway with an extract from a report of the Senate Committee on Pacific Railroads, dated 19th February, 1869; and I presume that no better authority could be obtained. By its text we learn that whilst immigration is actually being opposed in some of our colonies, the Americans are demanding with greater force than ever more hands and more brains.

"It can be shown by official records," says this report, "that Kansas Pacific, the Union Pacific, and the Central Pacific, have been instrumental in adding hundreds of thousands to the population of the states of Kansas, Colorado, Iowa, Nebraska, California and Nevada. Minnesota owes to the rapidity and cheapness of transportation by rail, her best immigrants—over 100,000 Germans, Norwegians, and Swedes. Every foreign labourer landed on our shores is economically valued at 1500 dollars. He rarely comes empty handed. The Superintendent of the Castle Garden Emigration Depot in New York has stated that a careful enquiry gave an average of 100 dollars, almost entirely in coin, as the money property of each man, woman, and child landed in New York. From 1830, the commencement of our railway building, to 1860, the number of foreign immigrants was 4,787,924. At that ratio of coin wealth possessed by each, the total addition to the stock of money in the United States made by this increase to its population, was 478,792,400 dollars." Well might Dr. Engel, the Prussian statistician, say:—"Estimated in money the Prussian state has lost during sixteen years, by emigrants, a sum of more than 180,000,000 of thalers. It must be added that those who are resolved to try their strength abroad are by no means our weakest elements; their continuous stream may be compared to a well-equipped army, which, leaving the country annually, is lost to it for ever. A ship loaded with emigrants is often looked upon as an object of compassion; it is nevertheless in a political economical point of view generally more valuable than the richest cargo of gold dust."

On the Geology of the Province of Wellington.*

By J. C. Crawford, F.G.S.

[*Lecture delivered at the Colonial Museum, Wellington, October 2, 1869.*]

The following notes were made during a geological survey of the Province of Wellington, undertaken for the Provincial Government, between 1861 and 1864. The original Reports† are now scarce, and I have been requested to draw up the following abstract of them for re-publication as a preface to the description of the district between Wanganui and Lake Taupo, which formed the subject of my lecture before the Institute.

Since the original publication of my Reports, our knowledge of the geology of the country has largely increased: Hochstetter's work has appeared, the Government Geological Survey has been in progress, and the New Zealand Institute has been established, and in its "Transactions and Proceedings" are numerous reports on the geology of the Colony. Of these new sources of knowledge I cannot take advantage, without entering into discussion, and thereby too much enlarging the limits of this paper; I will therefore confine myself to original observations.

In the classification of the strata I adhere as much as possible to the views adopted by Professor von Hochstetter.

Tabular view of the Strata in the Wellington Province:

Recent. 1. Travertin—found at Te Pura Pura, Hautotara, and other parts on the eastern side of the Wairarapa valley.

2. Raised beaches—extending round the coast.

3. Gravels—Wairarapa plains, Otaki, Manawatu, Rangitikei, Whanganui, etc.

Tertiary. 4. Gravels of high levels.

5. Sandstones and limestones—on east side at Hautotara, Maungaraki, and generally skirting the eastern side of the Wairarapa plain. On west side, covering the whole of the great tertiary field.

6. Blue clay—on east side, exposed at Wangaimoana, and very extensively found in the East Coast ranges. On west side, Whanganui and Rangitikei basin, and probably that of Manawatu.

Probable Mesozoic. 7. Limestones and sandstones of the East Coast.

Mesozoic and Palæozoic. 8. Slates and sandstones of Rimutaka and Tararua ranges, including all the mountainous country between the Wairarapa valley and the west coast at Porirua; and at Cape Palliser, and Kaimanawa range.

Plutonic. 9. Hornblendic rock—found in the upper tributaries of the Pahaua, as boulders: found *in situ* at Waikekino, not far from Flat Point.

Volcanic. 10. Rocks of Ruapehu and Tongariro, and boulders derived from them, pumice included.

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* For the localities mentioned, the reader is referred to the Map of the Province, accompanying Mr. Stewart's paper on "the River Systems of Wellington." See page 198 of this volume.—Ed.

† See Provincial Government Gazettes; also, Geol. Map and Sections (Ward and Reeves, 1864).

As it is not intended to give a systematic account of the geology, but rather a detailed narrative of the facts obtained by actual survey, I am compelled to adhere to the natural order in which the observations were made in the course of numerous journeys.

I will therefore divide my journeys into three sections.

1st. To embrace the main range, and its immediate vicinity.

2nd. The Wairarapa and East Coast.

3rd. The Whanganui, Rangitikei, and Manawatu rivers, with Taupo inclusive.

1. Main Range.

By the term main range is to be understood, all the mountainous part of the province which is bounded by the Wairarapa and the Forty-mile Bush on the east, by the flat country of the basins of the Waikanae, the Otaki, the Manawatu, and the Rangitikei on the west, and by the sea on the south and south-west. This district includes the ranges of Rimutaka, Tararua and Ruahine, with all their spurs and offshoots.

My explorations in the main range were performed in a series of traverses, which it is proposed to describe separately. The first on the list will be :—

JOURNEY FROM THE HUTT, BY THE AKATAREWA RIVER, TO WAIKANAE, AND THENCE BY BELMONT HILL TO WELLINGTON.

From the junction of the Mungaroa river, the Hutt takes a large bend to the west. At the extremity of this bend a considerable stream, called the Akatarewa, falls into its right bank from the westward.

Having forded the Hutt, I proceeded up the course of the Akatarewa. Two days journey of pretty constantly wading, brought us near the sources of the river. On the third day we crossed a dividing range about 2000 feet high, and descended upon a branch of the Waikanae. On the fourth day we reached the village of Waikanae.

The rocks traversed throughout the journey were of the usual character of those round Wellington—slates and sandstones highly inclined. Some plant impressions were found in the sandstones, similar to those at Porirua. A handsome agate pebble was found in the Hutt river, which, considering also certain igneous boulders which I found in the gorges of the Waiohine and the Ruamahunga, leads me to expect that igneous dykes may be found in the heart of the ranges.

The valley of the Akatarewa contains a considerable quantity of level terrace land, but from the dense nature of the forest, it is difficult to estimate the actual amount.

It is probable that a line of road will eventually be formed by crossing from the valley of the Akatarewa to that of the Otaki, and so connecting the Hutt and the West Coast.

On my return from Waikanae to Wellington, I took the track from Paoatahanui to the Hutt, apparently passing over a line of strike of soft sandstone and slate rocks, and finding plant beds.

THE HUTT VALLEY, GORGES OF WAIOHINE AND RUAMAHUNGA, FORTY-MILE BUSH, CROSSING OF TARARUA NEAR GORGE OF MANAWATU, AND ASCENT OF TARARUA BY THE OTAKI VALLEY.

In February, 1863, I organised a party to endeavour to find gold in the main range. My plan was to examine the different river basins within the ranges, and should gold even in small quantities be found in them, to bottom the plains, or basins lying outside the ranges on both sides.

I looked upon the Hutt valley, however, as almost a decisive test, for it is the great valley of Tararua, and should no gold be found in it, I felt little expectation of finding it elsewhere in these districts. We proceeded to sink a hole in a gully behind Mr. Brown's house, in the Upper Hutt, where some small scales of gold were previously reported to have been found. This hole was sunk through clay and debris, bottoming on hard sandstone, at a depth of eleven feet, without finding the "colour" of gold. In this hole, as in every other which we sunk, we obtained a small quantity of iron sand.

Our next endeavour was to bottom the gravel flats of the Upper Hutt in several places, but from the influx of water we found this to be impracticable; the river evidently percolates through the gravel right across the valley and the quantity of water was quite beyond the power of ordinary pumps. As, however, the bed rock of slate, etc., crops out in many places above this, both in the bed and on the banks of the Hutt, we were enabled to try the gravel where it rests upon the old rocks, but still without success.

We devoted a day to the hills above the Mungaroa swamp without success. We next examined the valley of the Pakuratahi and the gullies in the neighbourhood of Featherston, with similar results.

Passing the Tauherenikau, we proceeded to the Waiohine, which we prospected and washed at every available place for a distance of six or seven miles from the entrance of the gorge. As in the Hutt, it is impossible to bottom the gravel bed of any of these streams below the water level, but there is plenty of bed rock above the water level, with thick beds of drift resting on it. No appearance of gold was found. The rocks were similar to those found on the Rimutaka hill, including large quantities of soft pyritous slates with carbonate of lime veins, and veins of a black mineral, graphite. Boulders of amygdaloidal trap were found here, and also in the stream behind Featherston.

In the upper part of the Wairarapa valley, at the gorge of the Ruamahunga, the formation is gravel of large size, resting upon the blue clay, and in the river bed below may be seen the point of junction, where these tertiaries abut on the old and highly inclined rocks. The rise from Masterton is tolerably rapid, and on the Opaki plain, and the adjoining hills, are very palpable marks of the earthquake of 1855 and perhaps of other shocks; at one point there being a lift in the plain of perhaps thirty feet, and a tertiary hill having been split in two, and the western part having slipped down towards the river bed.

In the upper part of the valley of the Ruamahunga river, there is an appearance of a valley of some extent within the hills, but the bush is so dense that I will not venture to guess at the extent of terrace land which may be there. It lies, however, at a height of over 1000 feet above the sea. After rather stiff wading up the river for about six miles, we found the water become so deep from the compression of the bed of the river between perpendicular cliffs, about 150 feet high, that we were obliged to abandon the river bed and take to the forest above. We had by this time, after repeated trials, given up all hopes of finding gold, and were on the look out for a point from whence to ascend the central range; when, after we had proceeded for a mile or two through the bush, the weather suddenly changed, and it soon rained so hard as to force us to a precipitate retreat. My experience of the Ruamahunga was this, that one day's rain raised the river, on the following day it was in full flood, on the third day the stream was fit to travel, and on the fourth day it began to rain again.

Jaspar and green serpentinous rock are characteristic of the Ruamahunga valley. There is not much appearance of quartz. To a person desirous of reaching the top of the central range, the valley of the Ruamahunga offers the advantage of starting from an elevation of over 900 feet above the sea before

leaving the open plains, and the distance to the open country above the forest is comparatively small.

From the Ruamahunga I proceeded northward through the Forty-mile Bush. Our road descended to the Ruamahunga by the Maori track, crossed the river, ascended a terrace, and then passed over a hill called Kotukutuku, of no great altitude. This hill, however, I believe may be avoided altogether, by taking the line of road lower down on the Ruamahunga. In three hours we reached the Maungawhinau stream, said by our guide, Hemi Paraone te Ua, to be a tributary of the Ruamahunga, but my impression is that he is wrong, and that it runs towards the Manawatu basin. The road frequently crosses this stream, a disadvantage which might probably be easily obviated. After crossing the before described hill, the road was nearly level excepting an occasional ascent of a terrace bank. We encamped on the banks of the Makakahi, on an undoubted northern fall. It is a rapid stream, much encumbered with drift wood.

The weather was very rainy, and it took us two half days travelling through bush and upon terraces and alluvium to reach the Tutaekara pa, situated on an open flat on the banks of the Maungatuinoko river. Here we found a population of about one dozen very miserable Maoris, under a chief called Mikara.

The Puketoi range may be estimated as five miles distant to the eastward, and the nearest ranges of Tararua appearing to be about five miles to the westward would give a breadth to the valley of about ten miles.

From Tutaekara we proceeded across the plain to the banks of the Maungawha, where that river makes some great bends through cliffs of blue clay and gravel.

The next stream which we crossed is called the Ka-uki, near the junction of the tertiary sandstones and limestones with the vertical rocks of the main range.

The terraces of the Forty-mile Bush are in geological character similar to those of the Wairarapa. The rocks observed are tertiary sandstones, and some limestone, blue clay, and gravels. The rocks of the main range continue of the same character as further south.

Soon after leaving the Kauki we ascended abruptly the main range which here thins out to a comparatively narrow ridge ; we crossed it without passing into any valley. The distance from level land to level land on each side does not exceed four or five miles. From the ridge most extensive views can be obtained. The Puketoi range lies opposite—a scarped tertiary formation ; over its northern shoulder open country is visible to the eastward. To the southward may be seen the hills beyond Masterton ; on the western side the view extends over an immense area of level country. The view from this range gives a strong impression of the ultimate resources of the district. The rocks of the main range here show no change from those further south : the height of the range here is perhaps 2000 feet above the sea.

We descended upon Raukawa ; thence we proceeded down the right bank of the River Manawatu, travelling upon a rich alluvium, but observing occasionally the scarp of gravel terraces.

The mouth of the Oroua at Puketotara seems to mark the line of demarcation between the rich land of the interior plains, and the poorer sand tracts towards the coast, and as the aneroid marked exactly the same height at Puketotara as at Te Awahou, I would suggest that the principal township of the Manawatu, ought perhaps to be at, or near Puketotara, and the river navigation improved up to that point, in which case the main trunk line of road from Wellington to the North, would pass through and open fertile lands instead of traversing sand hills.

From the Manawatu we proceeded to ascend the Otaki river.

I was rather surprised at the breadth of fertile land between Otaki and the hills. It took us two hours hard walking (with packs), to reach the Wairarapa pa, and then we had not reached the hills. At the Wairarapa pa the question of the ascent of the river was discussed by the Maoris, and it was settled that a deputation of two was to accompany us to see that we did not carry away too much gold.

The valley of the Otaki river is remarkably similar to those of the Waiohine and Ruamahunga, but it is less wild and the cliffs are not so high. The river winds between cliffs about seventy feet high, composed of highly inclined slates, sandstones, etc., capped by gravel terraces, the latter formation of various thicknesses, from six to thirty feet. Mamaku and other tree ferns abound. The stream is rapid and quite deep enough for wading, indeed it was sometimes difficult to keep one's feet. As we approached the central range the Waitatapia was passed, falling into the right bank. Up this stream lies the road to the Ohau river. A short distance higher up, and we may say at the base of the central range, the Otaki divides into two branches, that from the northward retaining the name of the Otaki, while the southern branch is called the Waiotaueru. The northern branch is said to be full of deep holes and very inaccessible. We ascended the Waiotaueru for some miles, and encamped near where a stream falls into the right bank.

We were now in the midst of soft vertical slate rocks, which had been described to me as full of quartz veins, but the said quartz veins turned out to be carbonate of lime. The same pyritous slates with carbonate of lime veins which I had found in the Wairarapa rivers and elsewhere, were here very largely developed. In the neighbourhood I found the black mineral found elsewhere, viz., graphite, but no metal except iron pyrites is visible in the carbonate of lime veins themselves.

Ascending from Otaki we soon looked down upon the range above Waikanae, which I find the natives call Rimutaka, so that name is not confined to the range adjoining the southern part of Wairarapa. It now appeared to me that only one ridge separates the Waiotaueru from the Akatarewa, and that by turning to the right in the ascent of the latter river, and crossing one range, the Waiotaueru would be reached with ease. After about five hours climbing we found the trees become Alpine in character and covered with moss, and in five and a half hours we emerged from the forest upon the open ridges above at a height of about 4000 feet above the sea. The Alpine trees were mostly totara and black birch. The vegetation above the forest, shrubs of veronica, tarata, a sort of broom, moss, flax, toi and a little grass.

Here we were surrounded by snowy ridges and commanded a most extensive view. The Kaikouras were very distinct, and also the Bluff, and the land about Cape Campbell, with that part of Cook's Straits lying between the latter and the land about Wellington. The mountains surrounding us were broken into long and very steep ridges, separated by ravines some 2000 feet deep, all forest except the line over 4000 feet, which is open, but in which bushes are found, often as difficult to pass through as the bush.

There was no appearance of any level land within the mountains.

We looked down upon the Ohau valley, a deep ravine, but the view towards the far N.W. was shut out.

KARORI, MAKARA, AND TERAWITI.

The following remarks were made on those districts in December, 1861 :—

In November, 1861, I visited the Karori and Waiariki valleys, near Cape Terawiti, and although the men who had been at work at the diggings there were absent, and I was therefore unable to obtain various details, yet I

found an inspection of the valleys highly suggestive as to the direction in which a search for gold should be prosecuted.

There is nothing new in the mineral character of the rocks in the Terawiti district—they seem to consist of a slaty rock, laminated with veins of quartz; of the usual hard green crystalline sandstone, veined with thin threads of quartz, and some hornstone or chert, and some serpentinous rocks. All the above named rocks are repeated at various points of the Rimutaka and Tararua ranges, and, therefore, if gold be found at one point, the inference is that it may be expected in others. The same rocks, or some of them, may be seen near the Printer's Flat in Makara; at various points on the Karori Road; between Ngahauranga and Pitone; on the Rimutaka Road; and elsewhere.

It is evident that the slate range, which here constitutes the main range of the Island, does contain some gold. Gold is found in it at Terawiti, and in various other quarters, and therefore, after all, it may be an auriferous range —discovery also may soon show that it answers Sir Roderick Murchison's description of gold constants, viz., silurian rocks broken up by granites, porphyries *or greenstones*, inasmuch as I have found the eruptive rocks in the East Coast country, and I hope before long to find them in the main range itself; added to this we find serpentine in many parts of the range, and although few, if any, well-defined quartz reefs or lodes are found, yet irregular veins of quartz, large and small, are very common. On the other hand the quantities of gold yet found are small.

In considering the geological aspect of the district one enquires where is the most likely place to look for gold in quantity, and one naturally turns to the enormous development of gravel on both sides of the range, and in some of the valleys within it. It is found in small and irregular quantities in the different narrow valleys, including those of Waiariki, and the Karori stream, but denuded in places by the action of the streams. The Upper Hutt and Pakuratahi valleys have their deposits of drift, and probably in the Lower Hutt it will be found below the alluvium of the river; and in the Wairarapa this deposit is of great extent and uncertain depth.

PORIRUA.

On the shores of the Porirua harbour, between the Peninsula of Tutae Manu and Duck Creek, I discovered, in 1863, a series of strata, standing nearly vertical, and containing impressions of plants and carbonized substances. It was hoped that the finding of these fossil plants might have led to some scientific results, in establishing the age of the rocks; but the organisms have proved too indistinct and obscure to give any definite information. Taking the line of strike, I looked for, and found, similar organic substances at Oriental Bay, within the limits of the City of Wellington.

2.—Wairarapa and East Coast.

(Summary of Report.)

After returning from the exploration of the valleys of the Akatarewa and the Waikanae rivers, I again started with the view of gaining an insight into the geology of the N.E. part of the Province, more particularly in the direction of the Puketoe range, and the country generally, lying between the Tararua range and the East Coast.

Leaving the gravel of the Wairarapa behind me at Masterton, I found on rising the hills towards the Taueru station, that I had entered upon the tertiary sandstone. This rock I found extending over the whole of the interior of the North-Eastern district, resting upon the blue clay except where some gravel

intervened between the two, but the gravel is by no means largely developed in this district.

This sandstone consists of a series of soft fine-grained sandstones, fossiliferous, and alternated with fossil beds approaching limestone, and is sometimes of great thickness in this district, seldom less than 500 feet, and in some places I think it must measure 1000 feet.

Some of its fossils are *Turritella*, *Venus*, *Dentalium*, *Pecten*, *Struthiolaria*. I have no doubt that it is of the same age and character as the upper sandstone of the Whanganui river.

This formation, where found undisturbed, seems to lie nearly horizontal; but numerous hill sides have slipped into the valleys, there giving the strata the appearance to the casual observer, of dipping in various directions and at high angles.

From the vertical nature of the sections in which this series is found exposed, it has been impossible for me to make any but a partial investigation of its different beds, and the same difficulty is felt in the examination of the cliffs of the Whanganui and other western rivers,—they are so vertical as to be inaccessible.

The blue clay throughout this district does not show much of its thickness above the river levels.

Crossing the Manuka range, the road drops down to the Valley of the Taueru, and thence on to the Taueru station.

Here I visited a very beautiful waterfall, formed by the waters of the Mangarei, a tributary of the Taueru. The stream falls over a ledge of the tertiary sandstone to a depth of about fifty feet, into a large circular pool. Hard fossiliferous beds of this sandstone form the rocks at the fall, the softer overlying beds, which are found in an adjacent cliff, having been denuded.

I may here state that there is a remarkable parallelism between the effects produced in this district and in that of the country inland on the Whanganui and Rangitikei rivers, inclusive. In both districts are the tertiary sandstones largely developed, and in both have these nearly horizontal strata been broken up by denudation, into very rugged surfaces.

Many of the beds of the tertiary sandstone are extremely soft, and therefore liable to be rapidly worn away; some of them, indeed, on being struck by a hammer, instead of breaking into fragments, crumble and run down into pure sand.

Proceeding up the valley of that river, the Forty-mile Bush lay about three or four miles on my left, covering a very broken country.

Ascending the ridge on the eastern side of that river, one looks down on the valley of the Whareama, with its level flats and swamps, while to the northward may be seen the country drained by the Matai kuna, the Oahanga, perhaps also the Akiteo, and here I could see plainly enough that all within view was of tertiary age, the blue ridges of Tararua in the far distance excepted.

Crossing to the Puketoi range, which has an extreme altitude of only 2500 feet, I found the blue clay, and on the ridges above, tertiary sandstone beds, with the usual fossil shells.

Retracing my route to the East Coast, I crossed the Whareama river, passed over a hill and descended upon the Tinui station, situated upon the flats of that stream, a tributary of the Whareama.

Immediately above the station is one of those remarkable hills called "Taipo." These hills have an extremely fantastic, picturesque, and rugged outline, and at first give the impression of volcanic peaks, but on examination prove to be tertiary sandstones, tilted at an angle of about 70°, and here dipping to the westward; the harder parts of the strata sticking out in peaks, while the softer parts have been worn away.

On the top of the Tinui Taipo I obtained Turritella, Venus, Dentalium, etc. Here also I found that the Matai kona Taipo bore N. 50° E., Buxton's Taipo S. 20° to 30° W., and what I supposed to be Moore's Taipo S. 15° W. It will thus be seen that the several peaks run nearly, but not quite, in a straight line.

Proceeding on the 22nd towards the coast, the road passes for a short distance up the valley of the Tinui, where I found the blue clay. Crossing that stream I ascended a ridge, where a fresh geological series is found, consisting of white limestone and calcareous grits, and in their midst, a fine grained green sandstone.

Descending from the calcareous ridge to the valley of the Whakatake the road follows that stream to the sea, and thence south to Castle Point. We now find a series of thin and soft beds of sandstones and mudstones, cropping out on the beach and in the valleys, sometimes nearly horizontal, and sometimes inclined at high angles. What relation these rocks have to the limestones and calcareous grits, I am at a loss to determine, for I could not here find a section which would throw light upon the subject. My impression is that they overlie the calcareous rocks.

In these sandstones and mudstones I found small seams of coal and numerous impressions of vegetation, but none clear enough to be enabled to judge of their age, but as the coal seams appear to be lignite, or brown coal, we may put them down as of tertiary age.

The reef at Castle Point is a peninsula, forming the shelter to the anchorage. Both it and the rock called the Castle are composed of calcareous sandstone, resting unconformably on the sandstones and mudstones just mentioned. In it I found the usual tertiary fossils. The reef, which is a ridge perhaps fifty feet high, is penetrated by a cave, through which the tide passes, and in which the roar of the wind and waves is very striking. Between the reef and the Castle Rock, the sea has another passage through the rocks into a basin. The Castle Rock is of similar formation to the reef.

In the mudstones and sandstones on the shore I found plant impressions, and in consequence proceeded up the bed of the stream behind Castle Point in the hopes of falling in with some seams of coal. I went on as far as I could penetrate, perhaps three miles, finding plenty of plant impressions, but no actual coal seams.

Mr. Guthrie informs me, that some years ago one of his shepherds, who has since returned to Australia, brought in a handkerchief full of coal (stating that there was plenty more where he found it), which burnt well and seemed of good quality, and which must have been found within three miles of the Castle; but unfortunately he had neglected to ask him where he got it.

My impression is that the mudstones and sandstones of the coast are of tertiary age, and therefore if any workable coal seams are found in them, that the mineral will be of inferior quality.

On the beach here is some iron sand, whence derived it is difficult to say.

Near the Nakaua river I found soft sandstones containing plant impressions and some coal seams about two inches thick. They were not continuous, but thinned out in a yard or two. The rocks are the same as those at Castle Point, and dip slightly to the westward.

Ascending from the beach, in about a mile, I again came upon the calcareous grits and sandstones, both of which prevail in crossing the Trooper, the ridge separating the Whareama from the sea.

From this range the Puketoi is visible, its tertiary character being evident even from this distance.

Descending from the Trooper, I crossed the alluvium of the Whareama valley, and ascended the hill next to Buxton's Taipo, composed of calcareous

grit. The Taipo has a singular family resemblance to that at Tinui, and also dips to the westward.

From Telford's station the calcareous grits continue for about a mile, when the tertiary sandstone and limestone rocks again appeared, and continue all the way to Collins' bush, resting on the blue clay.

In this journey I settled the character of a large block of country, viz.,—the whole of the island within this Province lying to the N.E. of the Wairarapa, and between the Tararua and the East Coast. It will of course be desirable to complete a traverse which I propose to make, from the gorge of the Manawatu to the Akitio river and the East Coast, but as I have been through the gorge of the Manawatu, and as I have also been on the Rua Taniwha plains, and at Porongahau; I may very safely venture to predict that in the above named traverse, we shall find nothing but the above described tertiary rocks, with the underlying sandstones and limestones.

I should state that at a distance of about ten miles from the east coast an older series of rocks crop out, and extend to the sea; they are composed of sandstones and limestones. They are often inclined at a high angle, and are doubtless of Mesozoic age.

The streams which flow from the limestone ranges towards the Ruamahunga, deposit travertin in considerable quantities. I observed this particularly at Te Pura Pura and Hautotara. At the former place I found many beautiful impressions of ferns, possibly encrusted only a short time before.

A raised beach may be observed all round the coast except at the foot of the Wairarapa valley, where the sea encroaches on the soft rocks.

Igneous rocks are found *in situ* in the district. At Waikekino, near Flat Point, I found reefs of diallage on the beach, traversing Mesozoic limestone. In the valley of the Upoko Ngaruru, a tributary of the Pahaou, I found fragments of a similar rock, not actually *in situ*, but in a position where I think they must have come from a rock in the immediate vicinity.

At Cape Palliser the old rocks appear, and rising to a height of several thousand feet, are lost beneath the tertiaries at about the line of the Pahaou river, with the exception of some small ridges which are found further north—as between Huangaroa and Hildebrand's.

3. The Whanganui, Rangitikei, and Manawatu Rivers, including a Journey to Taupo.

Having been requested by the Superintendent to examine the rocks of the Whanganui river, and particularly the coal seams of the Tangarakau, a tributary of that stream, and having procured the services of Mr. Samuel Deighton, as Interpreter, and an efficient crew of Maoris, under the command of Topia Turoa, an influential chief, and son of Pehi, the great chief of the Middle Whanganui, I proceeded up the Whanganui in the end of the year 1861, accompanied also by Dr. Tuke and Mr. Walter Jowett.

In consequence of detention by bad weather and holidays, we did not reach Utapu, the residence of the owners of Tangarakau, until six days afterwards. A runanga was then held to deliberate as to whether we should be allowed to proceed to the coal seams or not, and the result arrived at was that we could not be permitted to ascend the Tangarakau.

As the Taranaki war had only finished a short time previously, not by victory on either side but simply by sessation of hostilities, and as many of the Whanganui natives had been engaged in the fight, it was perhaps not to be wondered at that there was some jealousy of the pakeha in the interior.

It was proposed to us that we might proceed as far as the mouth of the Tangarakau, returning on the same day, but as afterwards a demand was made

of a payment of thirty shillings to the king, for passing beyond our present limits, I declined the alternative, and, in consequence, we returned down stream.

I found the strata entirely tertiary. The surface of the country gave me the idea that it had originally formed a succession of terraces, rising by steps from the coast to the interior, but that the denudation of the soft strata, by the action of running water in the present lines of drainage, had so cut up the former level land, as to make it a very broken country.

There is a general horizontality of the upper strata, at least—the valleys are valleys of denudation; there are no valleys of undulation.

The distance of Utapa from the Whanganui township is estimated at about eighty miles by the river. From the hill above I obtained a bearing of Ruapehu, with a pocket compass, viz., N. 70° to 75° E., (the northern and southern peaks respectively.) This bearing would appear to make the distance in a straight line, thirty-four miles only.

The gravel in the bed of the Whanganui gives a good idea of the rocks which are to be found at its sources. I found the gravel to be principally composed of igneous rocks, viz., traps, tuffs, basalt, etc., but with a proportion, say one-tenth, of hard sandstone and indurated slate rocks, similar to the usual rocks of the main range. As we proceed from Wellington to the N.W., we find in the Manawatu gravel, no igneous rock—in the Rangitikei, a small proportion—in the Wangaehu and Whanganui, the chief part is derived from these rocks.

The slate pebbles in the bed of the Whanganui no doubt indicate slate rock at its sources.

In the ascent of the river we had passed numerous villages and found a large population. Parekino, Atene (Athens), Koroniti (Corinth), Ranana (London), Karatia (Galatia), Pipiriki, Ohinemutu, are some of the names of these villages. They are surrounded by cultivations of fruit trees and of maize, potatoes, wheat, tobacco, etc. The vine grows luxuriantly, peaches are in overwhelming abundance, although at the time not quite ripe. At Ohinemutu I found a lemon tree in full bearing, with excellent ripe fruit. Each village had generally an immense church, but, almost invariably, the church was in a ruinous state.

Pipiriki is the capital of the district. It contains a considerable population and a large extent of cultivation. It also possesses some charms of scenery, and is rather more open than other parts of the river. The Whanganui runs in a deep cutting far below the level of the surrounding country. Its immediate banks are generally perpendicular cliffs. On the summit of these cliffs is often a sufficient quantity of level, or of undulating land, on which lie the cultivations of the village. In many places the access to the top of the cliff is by ladders, the villages are entirely hidden from view, which on ascending the ladders are found large and populous. The country beyond rises to a height of perhaps 700 or 800 feet above the river, and is always densely timbered.

At the time of my visit the great lizard superstition was in full force on the Whanganui. A prophet had arisen who had stated that the cause of the disasters of the Maoris was the increase of lizards, that the lizard was the root of evil; that this animal had increased, was increasing, and ought to be exterminated.

In consequence large parties of Maoris were travelling through the country lizard hunting, and at Karatia we found the people cutting down a beautiful grove of karaka trees, to enable them to catch the lizards, that the prophet had informed them were in the trees.

In Hochstetter's section across the North Island, he has put in the Whanganui mountain called Taupiri, as volcanic. We passed near its base,

and I was unable to perceive any appearance of volcanic rocks about or near it. It appeared to me to be simply a scarp of marine tertiaries, possibly, for some reason or another, less denuded than the surrounding land. As Hochstetter was never in the district himself, he must have been misinformed as to the geological character of this hill. On our return we slept at Pipiriki, and on the following day reached the township of Whanganui, distant about fifty miles from Pipiriki.

ASCENT OF THE RANGITIKEI RIVER.

As I was unwilling to be baffled in the examination of the inland country, I next proceeded from Whanganui to Rangitikei, accompanied by Mr. Samuel Deighton, and having procured a canoe and a crew of four Maoris, commenced the ascent of that river. It was tedious work poling up the Rangitikei, but a canoe journey was the only one likely to give me an opportunity of making out the geology of the district, for the track to the interior is through thick bush, and few sections can be found off the banks of the river.

The geology of the Rangitikei is very similar to that of the Whanganui.

If we generalize the tertiary rocks of the latter river into three series, viz.,—

1. Upper sandstones. 2. Blue clay. 3. Coal shales.

We find in the Rangitikei basin a continuation of the two former. Whether or not the latter lies below, I was unable to determine, for I was never able to find the base of the blue clay, or the rock which lies below it.

In the Lower Rangitikei is a large quantity of gravel, chiefly of the usual sandstone and slate of the main ranges, but with an occasional boulder of igneous rock.

The view from the bed of the Rangitikei, is, if possible, more bounded by vertical cliffs than that of the Whanganui. As the traveller ascends, the cliffs get more vertical, the beds of the streams narrower, and the excavations form what are called in America by the Spanish name cañon*—vertical chasms. In the ascent of the Moawhanga, the stream is so narrow that the trees actually meet overhead. As the sun's rays dart through the gaps in the foliage the effect upon the eye of the navigator below is very remarkable.

The Rangitikei is very inferior in size and in facilities of navigation to the Whanganui. The rapids are far more numerous and the deep reaches few and far between. The chief tributaries fall into its right bank ; the largest of these are the Hautapu and the Moawhanga.

The junction of the Hautapu is about half way through the bush.

After six days poling up stream, we left the Rangitikei, and ascended the Moawhanga river.

In some parts of the Upper Rangitikei, I found the river obstructed by bars, composed of very large boulders of hard igneous rocks, apparently not *in situ*. How they got there requires further investigation. It is quite possible that igneous dykes may be found to traverse the district, but if these boulders have been transported, they must have come from Ruapehu. I looked carefully for any signs of igneous rocks *in situ*, but could not find them. The marine tertiaries, as far as I could see, occupied the whole district ; still, I will not deny, that a further search may discover what the tertiaries rest upon. I wish particularly to call the attention of future explorers to the question of the derivation of these igneous boulders. Broods of *whios* floundered about around them, some of which we succeeded in transferring to the pot.

The Rangitikei is, for purposes of canoe navigation, very inferior to the Whanganui. The river being smaller, the canoe employed is also smaller.

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* ñ is pronounced like gn in French.

The rapids are more numerous, and long deep reaches far less seldom met with. The native population in the higher parts of this river is small in number.

On the sixth day's voyage we left the Rangitikei, and ascended the Moawhanga for half a day's journey, passing through the narrow cañon already described. Our canoe voyage then terminated. We ascended the cliff, and walked to a pa called Pawerawera. Here we found no one at home, but made ourselves comfortable for the night, and on the following day proceeded to Papatahi, where we only found two men and some women and children. The inhabitants of the district had gone to Taupo to celebrate the obsequies of Te Herekiekie. From this point Ruahine appeared about fifteen miles distant to the eastward, with the tertiaries lying on its flank at about the same height at which we stood. I had wished to explore into one of its gorges, but found that my supplies would be insufficient. I was informed, however, that two days' poling in the Rangitikei, above the junction of the Moawhanga, will bring the traveller to the pa Te Awarua, and that probably from that pa as a base the Ruahine might be most easily explored; although a traverse from the Napier country would probably prove the easier operation.

Towards the east, in the direction of Napier, I observed tertiary hills capped with a scarped stratum, evidently limestone. From Papatahi, Ruahine was in sight, bearing N. 55° W., by compass.

We procured a guide and a baggage horse, and started for Taupo. Our route lay through an open and well-grassed country; but on both sides there was a large extent of forest in sight. We crossed the Moawhanga by a bridge over a vertical chasm, and slept at Pukehiwi. Leaving the valley of the Moawhanga, we traversed that of the Hautapu, the country improving in pastoral qualities. At Turangerere, on the Hautapu, there is a fine waterfall, and a pa of importance, celebrated for an enormous Waatu or store, built by the late chief Te Herekiekie, and called from its size *Niu Tirani*. We were still travelling over tertiaries, and at the Moawhanga bridge, at Turangarere, found "Venus," and other marine shells.

Encamped for the night at a pretty place called Poutamurengi, we bade farewell next day to the valley of the Hautapu, and crossing the Waitangi, passed from marine tertiary rocks to the volcanic products of Ruapehu. The ascent, although not very perceptible, was now rapid. We entered the valley of the Wangaehu, and gradually ascended it to its source. During this day I had observed the range of Kaimanawa, as we passed its southern end, rising out of the tertiaries. At a glance I saw it was a range of old slate rocks. On the rest of our way to Taupo it was on our right, a few miles distant. It is a powerful range, rising to an elevation of over 5000 feet. It is not a continuation of Ruahine, but lies to the westward of the line of that range, and is the highest part in structure of the North Island. Ruapehu was now on our left. On its eastern flank lies a small glacier, or nevé. Our guide, Tuakau, pointed out to us the marks of the avalanche which fell from this, and ultimately destroyed the bridge of the Wangaehu. The avalanche, after descending the mountain, was carried by its impetus for some miles across the plain, into the bed of the Wangaehu. The left bank of that river, being the highest, stopped the further progress of the avalanche, which consequently formed a dam. The river ran dry below, and formed a lake above, until the accumulated waters carried the debacle before them to the sea, sweeping away the Wangaehu bridge, some forty or fifty miles below.

We could perceive distinctly the marks of the progress of the avalanche across the plain. The ground had been bared, and large patches of bushes swept away.

As all the rivers from the Whanganui to the Rangitikei, both inclusive,

J. C. Crawford del. J. Buchanan lith.

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JUNCTION OF MOAWHANGA
with Rangitikei River.

flow in chasms, which may be blocked up at any time by an avalanche, by a fall of the cliffs, caused by an earthquake (as happened in the Rangitikei in the year 1855), or by other causes; an accumulation of water may be collected in the bed of any of these rivers, which, when it bursts, would be dangerous to any bridge not constructed with a clear waterway.*

Abreast of Ruapehu we passed the stone on one side of which the Wangaehu rises, flowing with bitter sulphureous water to the south. On the other side the Waikato flows clear and bright towards Lake Taupo, but before proceeding far it receives affluents whose waters resemble those of the Wangaehu. The watershed of these rivers is the highest point on the road. As we descended, vegetation improved in luxuriance, although all along the bases of Ruapehu and Tongariro, the plants are alpine in character. Kahikatea and black birch, full grown, but only a few feet in height, are common. The mountain torrents are frequent and very beautiful, but their height and rapidity during winter, and the depth of snow which is said to lie upon these plains, may prove a great obstacle to a permanent road through this high country, which shall be open throughout the year. We encamped on the banks of one of these torrents called Waihohonu, I think the prettiest of them all.

On the following day we reached Roto Aira, a lake of considerable size, lying under the northern slope of Tongariro, between it and Pihanga, an old volcanic cone. At Roto Aira we found a considerable village. The inhabitants were very civil, and after cooking food, supplied us with horses to ride to Tokanu, a village situated on the delta of the Waikato, here called the Tongariro, at the south end of Lake Taupo, which we reached in the evening. The river flowing from Roto Aira falls into the same delta.

The group of volcanic mountains which we had just passed, is of magnificent proportions, and if easily accessible, would attract many visitors. Ruapehu is undoubtedly the most ancient cone, and is also the most elevated land in the North Island, attaining a height of upwards of 9000 feet. Doubtless its volcanic forces have long been extinct. It appeared to me to be composed of the harder volcanic products.

Tongariro lies to the north of Ruapehu, and is a mountain of great size, but very inferior in elevation to Ruapehu. No visible signs of volcanic action now appear from the interior of its crater, but the grand active cone of eruption, called Ngauruhoe, 6200 feet high, is a lateral cone of this mountain, rising on its southern slope.†

My impression of Tongariro is, that when at its full elevation it must have been a volcanic cone of very great magnitude, considerably exceeding Ruapehu in height, but that the cone has fallen in, and the mountain is in consequence truncated.

Ngauruhoe is a regular cone of very graceful form, and reaches a height of over 6000 feet. According to the natives, its last grand eruption occurred about twenty-five years ago, when it threw out large quantities of stones; its top, they say, then fell in, and spoilt its beauty.

It always seems to send out volumes of smoke, and is said frequently to emit showers of fine ashes, which disagreeably affect the eyes. Rumbling sounds and discharges, as of cannon, are said to proceed from it.

It is a remarkable fact, however, that very few natives live in sight of the mountain, and sufficiently near to give a good account of its phenomena. From the village at Roto Aira, the cone of Ngauruhoe is invisible, and the

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* The character of these narrow chasms is shown in Plate 13.

† Since my visit, Dr. Hector has ascended Tongariro, and has found, and drawn, a lake lying in the bottom of its crater.

natives at the south end of Lake Taupo are shut out from a view of this mountain by intervening hills; while those living further north are too remote for correct observation. Consequently many phenomena may occur which are not observed. On the north-west flank of Tongariro, outside the crater, there is a large puia or hot spring, said to be a specific for certain diseases.

At Tokanu there is a very large area penetrated by hot springs, both in the delta, and on the surrounding hills; more particularly at Terapa, where the late chief Te Heu Heu was smothered by the hill side slipping down and overwhelming his pa in a torrent of mud. When I had seen the line of hot springs extending up the side of the hill whence the mass had fallen, I saw no difficulty in accounting for the catastrophe.

The hot springs, of course, decompose and soften the rocks, and afterwards, by the soaking of rain, slips are brought down.

At Tokanu I found gravel of slates and of quartz, probably derived from Kaimanawa. The hot springs here are very interesting.

The obsequies of Te Herekiekie were proceeding, and many hundreds of Maoris were present. The tangi and other ceremonies were going on all day. The weather was rainy, and what with a damp muggy atmosphere, and the steam of the hot springs, the climate was most relaxing.

I was anxious to visit Kaimanawa, but the Maoris showed so much passive resistance in the way of delays, that I was obliged at last to give up the idea. They were in an excited state, and although perfectly civil, they watched every movement we made.

From Tokanu we procured guides to the Upper Whanganui. Proceeding by canoe to Pukawa, we passed the lovely falls of Waihi. At Pukawa I met the late Iwikau te Heu Heu, and called on the Rev. Mr. Grace, the missionary of the district. In his house I "assisted" at a dinner in the collegiate style, called "commons," where all the scholars and every member of the household are seated at the same board. Pumice was largely employed in the construction of Mr. Grace's house, and he strongly recommended it as a building material.

From Pukawa we proceeded over an open pumice country, with very fine grass, on which we observed a flock of sheep belonging to the Maoris, as also a few cattle. After passing for some distance to the westward, we opened out splendid views of the volcanic group. The open plains are called the *Rua Mata*. At the entrance of the Whanganui bush we were obliged to find shelter from a furious thunderstorm, and to remain for the night. Here I was enabled to get good outline sketches of the volcanic group.

Entering the Whanganui bush on the following morning, we had a hard day's journey before we struck the Whanganui river, at a place called Terena. During the day we crossed a stream called the Waipare, and I found its bed composed of old slates with thin quartz veins. It was a matter of crossing two or three yards in which these slates were visible, but it was a great point to find that a base of slates was here to be found, and to form some idea of the thickness of tertiaries above them. As far as I could judge of a country covered by dense bush, I supposed the overlying rocks to be upper tertiary sandstones.

Terena is a pretty spot. We here struck the Whanganui on its right bank, and forded to the opposite shore. Proceeding down stream, we next forded the Whakapapa. In fording the Whanganui and its tributaries, which we had to do frequently, we had to hold on to poles held by all the party. The rivers were rapid and cold, and the stones being slippery, crossing was not unattended with danger.

Camping on the sand bank of the river to avoid the mosquitos, we started on the following morning, and reached the village of Tapuia Kumera, the residence, at that time, of Topini Te Mamako, the principal chief of the Upper

Whanganui. Topini, I found, was an old friend of mine, in the year 1840, in Wellington, so he treated me kindly, notwithstanding his having been a rebel in the Hutt in 1847, and afterwards having fought against us at Whanganui. He was busy getting in his wheat crop, and until that was done we could not get a canoe, so we were obliged to remain patiently. Topini informed me that slate rocks were found two days' journey up the Whakapapa, and he said that they contained a metal—possibly cubes of iron pyrites. This information is probably correct, supported by my discovery of slates in the bed of the Waipare.

At Tapuia Kumera there is a considerable extent of flat land, and since striking the Whanganui we had passed many cultivations. Groves of peach trees were common, and wheat, maize, tobacco, potatoes, etc., were cultivated.

Hereabouts series of strata are largely developed, which, although I discovered no coal seam, I have no hesitation in putting down as coal shales. They dip to the S.W. at an angle of about 20°, and contain plant remains. The terraces, and immediate banks of the river, are chiefly formed of pumice and volcanic ashes, sometimes forming tufa.

I may here call attention to the enormous quantity of pumice which must have been thrown out by the central volcanoes. Terraces of immense extent in the interior, are formed chiefly of pumice, and the rivers flowing from them, such as the Waikato, the Wairoa, the Whanganui, are constantly floating pumice to the sea, on the west, the south-west, and the eastern sides of the island. At the township of Whanganui tons of pumice are constantly floating past, and should the article be of any commercial value a vessel could load at her anchorage in mid-stream, by merely putting out some sort of net to catch the pumice as it floated past.

Two or three miles below Tapuia Kumera, the Ongarue, a tributary of large size, falls into the right bank of the Whanganui, at a place called Taumarunui. Ongarue receives above this junction, the waters of Te ringa motu, and from this point an open country is said to extend, with only one intervening bush, to Ngaruawahia.

At length Topini's harvest was garnered and secured, and we commenced the descent of the river. From Tapuia Kumera to Marai Kowhai, the next village of importance, and the chief residence of Topini, we occupied nine and a half hours transit, giving a distance of probably more than sixty miles.

In this distance we passed the Paparoa rapids, the worst on the river. Above these rapids the coal shales pass beneath tertiary limestones and blue clay, which latter continue far down the river.

Marai Kowhai is situated in the angle on the south side of the Ohura river, where that river joins the Whanganui, falling into the right bank. At this village commenced the warfare with the Ngatitu tribe who were conquered some years ago by Topini.

The Ohura river passes into the Whanganui after descending two waterfalls, in the neighbourhood of which coal seams crop out.

I am informed that this river traverses a fine open country in the direction of the Waipa and the district of Ngatimaniopoto.

On the following day we passed the mouth of the Tangarakau, on our descent, in two hours and three quarters from Marai Kowhai, a distance of about twenty miles. The sources of the Tangarakau must adjoin those of the Waitara.

We find, therefore, three lines of communication opening from the right bank of the Whanganui—

1. To the Waikato, by the line of Ongarue.
2. To the Waipa, by the line of the Ohura.
3. To the Waitara, by the line of Tangarakau.

From Marai Kowhai we reached Pipiriki the same evening, occupying nine hours twenty minutes in the actual transit. As the river was in strong fresh I do not think our rate of speed was less than seven miles an hour, which would, therefore, give a distance between these places of sixty-five miles.

On the following day we reached the township of Whanganui, passing through a district which I have already described.

The results of this journey may be stated as follows:—

1. That from the flanks of Ruahine a broad sedimentary tertiary belt extends throughout the Province of Wellington, in the direction of Taranaki, bounded inland by the slates of Kaimanawa and the volcanic rocks of Ruapehu.

2. That coal measures show at three points, viz., at and above Ongarue, at the Ohura, and up the Tangarakau.

3. That the presence of a base of slate rock is established to the westward of the great volcanic group, viz., in the bed of the Waipare.

The number of waterfalls passed on the banks of the Whanganui is remarkable, and perhaps unique. Below Maria Kowhai I counted 108 which we passed during one hour, and a corresponding number might be counted for two days' journey down stream. Of course some of them are not permanent.

ASCENT OF THE MANAWATU.

Leaving Whanganui for the Manawatu, I examined the basin of the Turakina for some miles up, but perceived nothing except the usual tertiary rocks.

Arrived at the Manawatu, I proceeded by land to Puketotara, a native settlement near the junction of the Oroua with the main river. Here I obtained a canoe, and after a tedious voyage against a flooded stream, reached the junction of the Pohangina, which falls into the right bank of the Manawatu, a short distance below the gorge.

The Manawatu country lies low compared with the districts previously explored. There is, however, a blue clay which shows on the banks of the river, and which becomes more exposed on approaching the ranges; this may perhaps represent the blue clay of the Rangitikei and Whanganui, containing *cucullæa*, etc., but, as I was unable to find the characteristic fossils, I am not prepared to decide this point.

The blue clay is capped by gravel about twenty feet thick.

At the camping place at the Pohangina I obtained *venus* and *pholadomya*

Near the range, the tertiary strata dip to the westward at an angle of 20° to 25°, whereas lower down they appear almost horizontal.

From the camping place on the Pohangina we passed through Te Apiti (the gorge). The river has here cut its way through the usual vertical slate and sandstone rocks of the main range. It is a remarkable geographical feature, to find a large river rising on the eastern side of the main range of the island, and breaking its way through, to fall into the sea on the western side.

Passing through the gorge to the Twenty-mile Bush, we emerged upon a level forest country, where I immediately found tertiaries and fossils similar to those I had left on the lower side.

After proceeding for some miles further through banks of gravel, I decided to retrace our steps. In our descent the time occupied in traversing the gorge occupied just one hour. Its length, including windings, cannot therefore exceed six or seven miles.

The Tararua range from the south here meets the Ruahine, both narrowed in width, and of comparatively low elevation.

It will be perceived that in the examination of the basins of the Manawatu, the Rangitikei and the Whanganui, almost the whole of the country is covered by tertiary rocks. This tertiary field appears also to extend over the greater part of the adjoining Province of Taranaki, and passes below the sea level into Cook's Straits.

In the basin of the Whanganui, at the base of these tertiaries, the coal series crops out. I have mentioned three points at which this occurs, viz.,—at the Tangarakau, at the Ohura junction, and above the junction of Ongarue.

An inspection of the map will show that these three points lie in a straight line, on a strike of about N.N.E. The dip, where observed, appeared to be to the S.W. I consider that there is little doubt that this formation extends throughout to the westward, to the coal seams of Mokau and the West Coast. It may be *faulted*, and in places beyond reach, but the probabilities are of its extension throughout this district.

Does this coal field also extend to the eastward, and crossing the Whanganui underlie the tertiary rocks of the Wangaehu, the Turakina, the Rangitikei, and the Manawatu? This is a point of great interest and of great importance, and one which may not be very easy to decide.

The importance of the question will be admitted when it is perceived that a proof in the affirmative would establish the district as the great coal field of New Zealand. I do not speak of the quality of the coal, for that is a point which must be decided after its discovery in different localities, but whether it should prove a coal of very first quality or not, its presence throughout this large area would be of enormous consequence, and would probably add to the advantages of a fertile soil, already enjoyed by the West Coast, the certainty of the future seat of manufactures.

So far as my observations went, this coal question cannot be settled without sinking. Nowhere to the eastward of the Whanganui valley did I find the outcrop of the coal or coal shales; but of course in other localities than those passed, this outcrop may be found, and every exertion should be made to find it.

Is the line of outcrop from the Tangarakau to Ongarue the summit of an anticlinal axis of the coal, or does it show a line of *fault?* The latter is the more probable supposition. But the main point to be decided is whether the coal series is found at all to the eastward of the Whanganui valley.

On the eastern side of the province I have found small coal seams at various points, and indications of coal in others, and it is possible that workable seams may be found on that coast.

With regard to the probability of gold being found, I have little to add to, or to alter, in the paragraph on that subject in my Essay published in the "Transactions and Proceedings" of last year, and written in January, 1865, except that at Terawiti a small quantity of gold continues to be found, and that a pyritous specimen from the Wai nui o mata has proved slightly auriferous.

ROAD FROM THE WEST COAST TO THE INTERIOR.

I will briefly summarize my reports on this subject by the following observations.

The open country on the West Coast of the Province of Wellington is separated from the open country of the interior by a broad belt of bush. This belt has proved an obstacle of no slight magnitude, both to the settlement of the inland country, and to the rapid concentration of military forces in the neighbourhood of Taupo. A road once opened through this tract would tend very much to the breaking down of the lines of demarcation between the provinces of the North Island, to the mutual advantage of each, politically and com-

mercially. Stock might then be driven from Whanganui to Auckland, produce would be raised in the interior, and would find a market on the coast, and settlement and population would spread through the country.

It is true that from Napier the journey to Taupo is comparatively easy; but persons wishing to pass from Whanganui to Taupo will have to make a very long journey if they go by way of Napier.

In the matter of defence, an attack made upon the Napier or Poverty Bay districts, might, with the rapid information conveyed by telegraph, be at once taken in rear from Whanganui, were this road once opened. A force stationed at Taupo might, in a case of danger, be also promptly reinforced from the West Coast.

Whether the line of the Wangaehu, or that of the Rangitikei is the better to adopt, is a matter for the surveyors to determine.

ON MINING IN NEW ZEALAND. By JAMES HECTOR, M.D., F.R.S., Director Geological Survey of New Zealand.

[*Abstract of Lectures delivered at the Colonial Museum, Wellington, on July 24 and 31, and August 21 and 28, 1869.*]*

NEW ZEALAND was not, like many other countries, first colonised on account of the attractions which its mineral wealth offered, and yet it is worthy of remark how early in the history of its occupation we find that mining was practised.

The earliest mine opened in New Zealand was at the Island of Kawau, which now belongs to Sir George Grey, where a vein of manganese ore, and soon afterwards, a copper lode, was opened up in 1842. Coal was also worked in New Zealand, for the first time in 1842, at Motupipi, in the Province of Nelson, so that these two great elements in the manufacturing progress of a country, fuel and metalliferous ores, were brought into notice at the same date, but in localities far apart, within three years of the formation of the colony.

The natives appear to have known nothing of the use of metals, and to have had nothing derived from the mineral kingdom in their possession, which would be deemed useful by the white man. The weapons and implements of the Maoris were made altogether of wood, bone, and stone, and it is a very significant fact for Ethnologists that a race possessing such acute power of observation, should not have made further progress; for had they brought with them to this country any traditional knowledge of the use of metals, they could hardly have failed to have discovered their presence in these islands. They do not, however, deserve the low status accorded to them by Professor Cotta, in a recent lecture, who in describing, in a peculiarly lucid manner, the steps by which man has advanced in the application of natural substances to supply his wants, says:—"On account of the implements prevailing, or at least preponderating in successive periods of time, the history of civilization has been divided into stone, bronze, and iron ages. * * * The stone period was divided afterwards into an older and younger, according as the workmanship was very rude or otherwise. But in some parts of the world, wood, bone, and shell appear to have been used in place of stone. The New Zealanders in the earliest times, and indeed till quite recently, have made their implements and weapons of very hard wood. *They have never had a stone period.*"†

And again in another passage he remarks:—"Whilst in Europe and many other parts of the Old World, the age of iron had long been introduced, the inhabitants of America continued for centuries to use weapons made of copper, bronze, or stone, and the inhabitants of New Zealand, of *hard wood.*" ‡

As a sufficient answer to these statements, it is only necessary to point to the cases in the Museum, which show every variety of stone weapon and implement used by the Maoris, from the flakes of chert, belonging to a very

* These lectures were chiefly explanatory of geological plans and sections, and having been delivered from notes, and imperfectly reported, are now given in the following condensed form.

† "Geology and History." By Bernhard von Cotta, pp. 29–30.

‡ *Ib.*, p. 33.

ancient period, up to the highly-finished *Mere Pounamu* which is still used as a weapon in warfare, and as a symbol of independence. Only the other day we heard how Te Kooti, in his progress through the country, thought it of importance to wrest the *Meres* from all chiefs through whose territory he passed, which shows the traditional value attached to them. However, the Maoris appear never to have passed beyond the so-called stone period, although they were sufficiently advanced in intelligence to appropriate at once to their own use the most improved forms of the implements of the iron age, when placed in their hands by the white man.

It is therefore since the settlement of this colony that the metallic ores, already found, have been discovered, of which we have the following:—

Gold—nearly pure, or alloyed with silver or copper.

Silver—in its native state, as well as sulphide, has been detected, but only in small quantities.

Mercury—both native, and as sulphuret or cinnabar.

Copper—in its native state, and as sulphide, silicate, oxide, carbonate.

Lead—as sulphide.

Iron—as magnetite, hematite, bi-sulphide, carbonate, and titaniferous iron.

Together with these ores, chromium, zinc, antimony, arsenic, and others in smaller quantities.

These constitute the class of mining products that are excavated from mineral lodes, occupying veins and crevices, or fissures in rocks, but we have also coal and iron ores occurring, interbedded with stratified rocks, and from our superficial deposits of sand and gravel, a rich harvest of gold dust has been obtained. If we include the last group among the mining products, we should not omit building-stones, slates, limestone, cement stone, brick clays and other materials of construction; but although these all form part of the mineral wealth of a country, the term mining is usually restricted to those mining operations that require a command of capital and skilled labour. It is no doubt true that in these colonies "diggers" of alluvial gold are termed miners, and certainly the gigantic works which they sometimes undertake, may fairly entitle them to be considered so; but still I think much inconvenience will arise if a distinction is not made between "diggings" and "mines," the former providing employment for independent individual labour, under temporary tenure, the latter only for an organized system of labour, and the speculative application of capital, the condition requisite for which, is security of tenure.

In New Zealand, as in all other parts of the world, accident has frequently led to the first discovery of valuable minerals, and this is not to be wondered at when we consider how many acute observers are found among the first settlers in a new country, where every unfamiliar object excites wonder and curiosity.

A systematic survey, however, with the assistance of the experience embodied in the sciences of geology and mineralogy, greatly increases the chance of finding minerals, by indicating those areas which will reward a more thorough investigation, and limiting the search to profitable fields.

After the actual discovery of a mineral lode, scientific knowledge is also equally useful in order to encourage and direct the operations when the indications are favourable to success, and to repress too sanguine speculation when they are the reverse. This latter duty is a thankless task, but still not the less important and useful in assisting the true progress of a country. It is especially important in all new countries that those mines should be first worked which show the greatest chance of success, as failure is sure to create distrust on the part of capitalists, and what is still worse, to discourage further explorations.

There is one other point on which I must say a few words of caution, respecting the relation of geological science to mining. Geologists are too frequently called on to predict where mineral wealth may or may not exist, but notwithstanding the great advances which have been made in geology, we must admit that the science is still a mere digest of observed phenomena, highly qualified to enable the student to observe and record with accuracy, but not having yet attained to generalizations that warrant prediction on this subject. A positive assertion that minerals exist in "such a district," or "in such a direction," is very easily made and can never be positively disproved. It is therefore quite safe, and likely to catch any credit that may arise from future discoveries, but I am glad to say that it is rarely that true science ventures on such predictions. It is very different in the case of a positive assertion that a mineral does not exist in any particular locality, or, that it cannot exist under certain conditions, which is a statement that should only be ventured from actual observation, as it can, if incorrect, be at once confuted. Geological science will not, therefore, enable us to dispense with diligent and extended search.

Before proceeding with the description of the localities where mines have been opened, it is desirable that I should state briefly the leading features of the geology of New Zealand.

The whole group of islands may be looked on as a narrow mountain ridge, rising from a deep ocean bed and extending in a N.N.E. and S.S.W. direction. The form of the coast is determined by the outstanding bluffs of harder primary formations, or by massive volcanic rocks that belong to the latest Tertiary periods. These hard rocks, and especially those last mentioned, have been the means of preserving patches of upper Secondary and Tertiary formations, which occupy a larger proportional area in the North than in the South island, where the mountains are loftier and occupy a greater breadth of country.

We find, on a closer examination of the structure of the mountain system thus described that it is by no means uniform throughout, but that the rocks composing its southern portion are of much higher antiquity, and show evidence of having been subjected to chemical changes at a greater depth in the earth's crust. This difference is evidently due simply to the southern mountain mass having been elevated to a greater extent as compared with the sea level, than that in the north, and, in consequence, a much thicker layer of the superficial and unaltered rocks has been removed by atmospheric denudation. A few years since it might have seemed absurd to have attributed the present form of mountains, thousands of feet high, traversed by valleys extending even beneath the sea level, to denudation, or to have held that they are the mere core of former mountains of greater magnitude, worn down by the long continued action of ice and running water. But now such a view is in accordance with the best matured opinion.

It is therefore to deficient elevation towards its northern extremity that we must attribute the absence at the surface of many of the rock formations which are prominent in the southern portion of New Zealand, and we must conclude that in the north the same rocks exist at greater depths, and are probably still undergoing chemical changes that have ceased to operate on their southern equivalents.

The sequence of geological formations in New Zealand is abruptly broken about the close of the Lower Mesozoic period.

All the formations prior to this have been, wherever they occur, more or less cleaved and jointed, so as to be hardly distinguishable from the oldest primary slates and sandstones, combined with which they constitute the main part of the rocky framework of the islands, and form some of the highest mountain peaks.

The sub-divisions of the oldest stratified rocks have not been determined, but the fossils already obtained show that they represent groups from the Upper Silurian to the Triassic periods.

The chief mountain range, consisting of these formations, extends from the east coast in the northern part of the Otago province, in a curved line defining the western limit of the Canterbury plains, to Cook's Straits, from where it extends through to the North Island, as a series of intermittent ranges, each trending N.N.E., but as a whole having a direction to the west of north. A second range of the same formation extends from the S.E. of the Otago province, and crosses the island to Jackson's Bay, but is not continued northwards, although outliers are found at some points as far north as Cape Farewell, resting on and altered by the older rocks.

In the central portion of the Province of Otago, included between the two lines as above described, foliated schists are exposed at the surface over an area of 10,000 square miles, comprising micaceous, chlorite, and quartzose schists. This is the district of New Zealand in which the largest quantity of gold has been obtained. On the steep western slope of that portion of the Southern Alps, culminating in Mount Cook, the same schistose rocks are continued as a narrow irregular band for half the length of the island, and then again appear at intervals as far as Cape Farewell. These schistose rocks are only known on the east side of the main line of the New Zealand Alps, in two places, one in the south of the Province of Canterbury, on the Waitaki river, and the other close to Cook's Straits, between the Waiau and Wakamarina rivers. In the North Island this formation has not been detected.

The remaining division of the older rocks is best developed in the S.W. corner of Otago where massive mountains of granite, gneiss, and other crystalline rocks occupy a very extensive area.

The chief characteristic of these mountains is their cubical form, due to their being intersected in all directions by profound but narrow valleys, with abrupt precipitous sides to three-fourths of the extreme height of the adjacent mountains. The valleys are partly occupied by arms of the sea, and inland lakes that resemble the Norwegian Fiords, and present most wonderful mountain scenery, that is easily accessible, and yet almost unvisited.

The same granite formation extends to Stewart's Island, and others of the outlying islands of the New Zealand group in a southerly direction. It also occurs at intervals along the west coast northwards to Cape Farewell, but it is frequently difficult to distinguish it from the granite porphyries which will be mentioned in connection with the rocks of the Igneous class. In the North Island no granite has been found corresponding to the old gneiss-granite above described, but dykes of granite-porphyry occur on the Barrier Island.

Let us now turn to the formations that belong to the periods after the break which has been described as occurring in the Mesozoic period, and we find a successive repetition of terrestrial beds with seams of coal and plant remains, with clays, marls, limestone and sandstone, in the manner usual in Secondary and Tertiary formations. The earliest plant remains show many forms that are now extinct, but associated with them are a few that cannot be distinguished from those of the existing Flora. In the newer carbonaceous strata, the resemblance to the existing forms is still greater, some of the peculiar and characteristic trees of the New Zealand forests, such as the Kauri, being well preserved. There is, therefore, very little doubt that since the upper Mesozoic period, dry land has existed continuously, and that some part or other of the New Zealand ridge has always been above water. The succession of marine fossils divides these formations into well marked groups characterised by changes in the species of marine animals on the coast, and showing a gradual

passage from forms allied to the South American types, to those of the Australian seas.

The occurrence of Secondary Cephalopods and Saurian reptiles in the lower groups renders it probable that the strata range from Jurassic formations upwards. But this is a subject pertaining purely to geology.

I will next proceed to describe briefly the Igneous rocks found in these islands, some of which have a more direct relation to the presence or absence of minerals than any of the foregoing.

Among the crystalline rocks we find Syenites, and many varieties of Hornblende and other basic rocks, but they are chiefly to be considered as varieties of metamorphic rocks. In the great Schistose area of Otago, there is a very marked absence of all Igneous rocks, except towards the eastern border, where Dolerites, belonging to the Miocene period, have escaped through the Schists at a few points, but without influencing their mineralogical character.

It is not till the period of the lower Mesozoic rocks, previous to the break in the geological sequence which I have described, that any contemporaneous Igneous formations have been detected. These consist of Diorites, Diabase, and Porphyries, associated with mechanically-formed strata of the same materials (Diorite sandstones and Breccias), containing fossils that indicate the period to which they belong. This formation is associated with a variety of altered rocks, of which Serpentine is the most prominent, and on the whole closely resembles in character the Diorite formation of South America, as described by Darwin and David Forbes. These Diorite rocks are found along a line that extends almost continuously through the South Island, chiefly along the western slope of the mountain axis, but they also appear in one or two localities on the eastern side of the range, though there presenting somewhat different characters. As the best known example of this formation I may instance the Dun Mountain, and mineral belt of Nelson.

What I take to be the same formation occurs in the North Island among the older rocks of the Colville peninsula, Barrier Island, and other mining districts. The relative date of the different Igneous rocks, subsequent to the foregoing, can generally be determined with considerably certainty. They present great variety, and belong chiefly to the upper Tertiary period, but it will be found, as our observations are extended, that volcanic outbursts were taking place in the New Zealand area, at almost every period subsequent to the Mesozoic Diorite series. The influence of the more modern volcanic rocks in producing mineral lodes and veins has been very slight, the only well-established cases being when they have been erupted through the Igneous rocks of the Diorite group, as at Coromandel and the Thames.

Keeping clearly before us these leading characteristics of the geological structure of New Zealand, it is highly interesting to compare them with the structure of the nearest large mass of land in Australia.

Extending along the eastern border of the Australian continent, we have within a short distance of the coast the Australian Cordillera, a main range of Primary rocks, flanked on the east side by a shelf-like remnant of Secondary strata, comprising the various coal fields of New South Wales, while on the west side is an expanse of low-lying country, where only very modern Tertiary formations are found. Towards the South end of the range in Gippsland, we have masses of granite lying to the west of an area of Mica slate and other metamorphic rocks. The marked resemblance of the natural features of this district to the Otago province of New Zealand has been frequently mentioned by diggers, while the analogy of geological structure in the two districts has been the subject of correspondence between Mr. Selwyn, the late Government geologist of Victoria, and myself. Now I find that by covering the Australian Cordillera in a map of Australia, with a tracing of

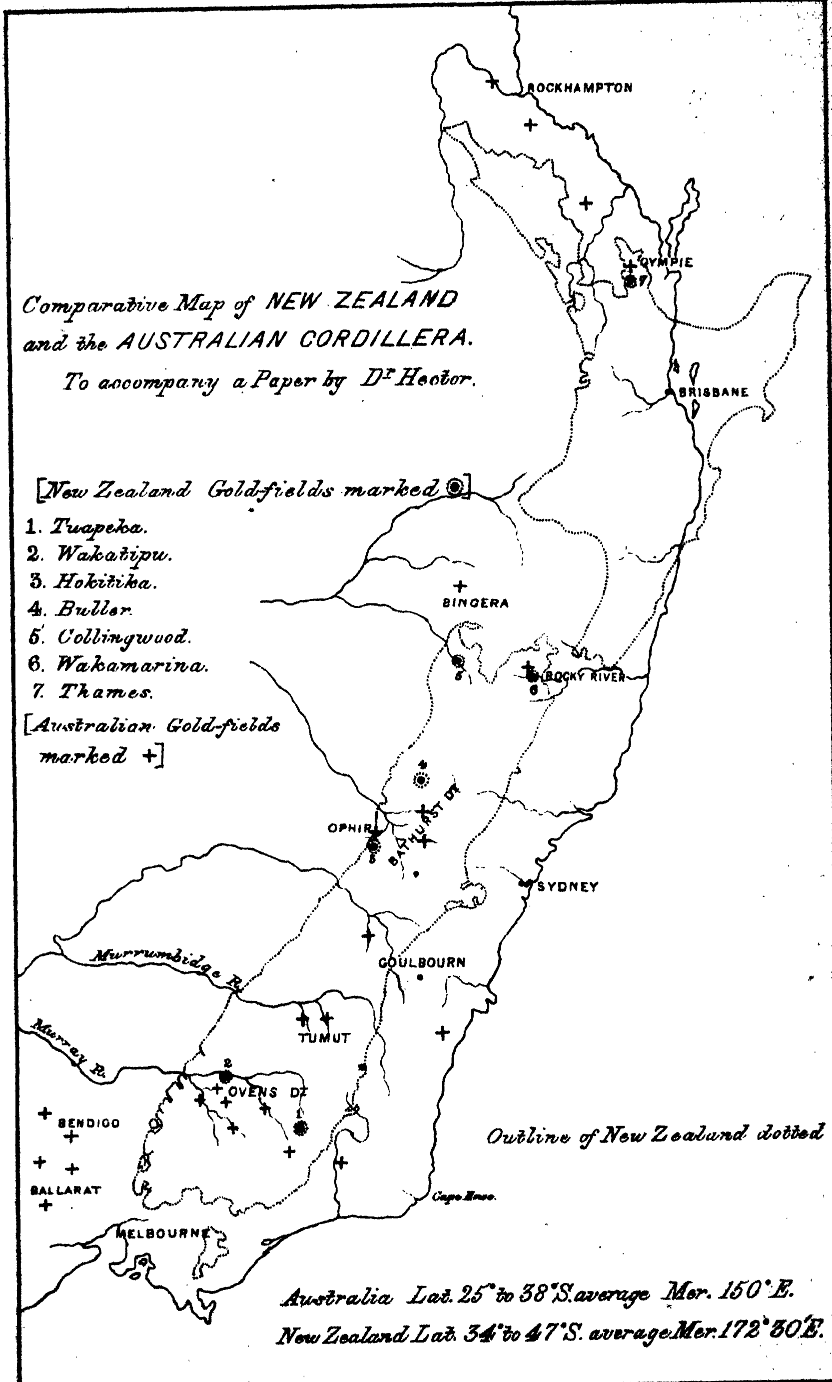
New Zealand, drawn to the same scale, placing the Otago Mica-schist area directly over that of Gippsland, and making the meridians parallel, that there is a wonderful coincidence between the relative position of the goldfields in the two countries, the chemical character of the gold, and the nature of the associated rocks and minerals.

New Zealand, thus compared, equals in length from Gippsland in Victoria, to Rockhampton in the north of Queensland, a range of territory which is important to the question of relative mineral wealth, when we also observe that New Zealand covers in width the mineral bearing ridge or Cordillera of Eastern Australia, having the ocean on the west instead of the Murray plains, and on the east only small areas of the carboniferous rocks.

By referring to the accompanying map (Plate 21), in which the relative extent and position of the two countries is shown at a glance, it will be found that the chief Victorian diggings, such as Ballarat, Castlemaine, and Bendigo, lie altogether west of the New Zealand boundary, and this is quite in accordance with the absence of any geological formation in New Zealand similar to the highly-cleaved Silurian strata of those gold fields. Then selecting for comparison the chief diggings in both countries, we find that Beechworth, Snowy Creek, and Omeo, correspond exactly in area and position with the richest diggings of Otago. Ophir exactly covers the position of the chief Hokitika diggings; while the Bathurst district has its analogue towards the south of the Teramakau. Bingera lies a little to the north of the Nelson gold fields, and the Rocky River diggings cover those of the Wakamarina. Continuing northwards there is a long gap without auriferous localities in both countries, till we are struck by finding that Gympie creek, in Queensland, exactly agrees with the Thames diggings. With more perfect maps of Australia than those at my command, and especially one showing the geological formations, it might be interesting to follow the analogy into its minute details, and so far as I am able to judge from the information I possess, it would be fully borne out.

From the description of the New South Wales gold fields, by the Rev. W. B. Clark, I gather that in the southern portion of the Cordillera, the gold, which is of good quality—containing less than 6 per cent. of silver—is chiefly found in that part of the country composed of Hornblendic granite and Mica schist; and this, as before stated, corresponds with the general character of the Otago country.

In what he terms the western district, which on our map corresponds with the Nelson district in New Zealand, he describes it as characterised by irregular areas of Hornblende granite, with locally transmuted members of the upper Palæozoic group, and Serpentine charged with Chromic iron, where the rocks have been altered by dykes of Diorite. This description is quite applicable to the Nelson district, and, moreover, in both districts the gold is found to be alloyed with from 10 to 14 per cent. of silver. At Gympie creek, in Queensland, we learn from reports by the Government geologists, that the gold is obtained from reefs traversing decomposed Diorite rocks, associated with masses of tufaceous Breccia aud Conglomerate. Areas of soft felspathic schist also occur, the whole series of formations being intersected by dykes of Diorite. From a collection of the rocks of this district, lately sent to the Museum by Mr. T. Hacket, I select many that cannot be distinguished from Thames specimens: the quality of the gold is also identical, and highly characteristic, as it contains over 35 per cent. of silver, and is found along with small quantities of lead, arsenic, antimony, copper, and other metals. Among the rock specimens it is interesting to find some taken from mines at Gympie Creek, that from their appearance at a first glance, and also from their chemical composition, would be classed as Diorites, yet distinctly containing fossils of the same species that characterise our upper Palæozoic and Triassic rocks.



J.B. lith.

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These general coincidences between the distribution of the minerals in the two countries, I believe to be more than accidental; and I only venture to advance them in this imperfect manner to show that in both the Australian and New Zealand mountain systems we have the same mineral fields represented on parallel lines, which lie at the same angle to the meridian in each case; and further that the peculiar features of each is repeated at equal intervals, distinguished especially by the deterioration in the value of the gold, as we pass northwards in both countries; the only material difference being that New Zealand is situated geographically nine degrees further south, than that portion of Australia.

Gold Mines.

Gold was discovered within less than three years of the foundation of the colony, in 1840, but it was not practically worked until 1852, when the mines at Coromandel first attracted attention to the same district that at the present time forms the chief seat of mining operations in New Zealand; but the yield from those mines has, up to the present time been small, when compared with the quantity of alluvial gold obtained in the South Island, subsequent to 1861, at which date the gold fields of Otago became prominently known. I have already alluded to the peculiarities of the manner in which gold is distributed in New Zealand, and taking these as a guide we naturally divide the gold fields into the following districts for convenience of description :—

1. The Northen gold field.
2. Nelson and Westland, or Western gold field.
3. Otago, or Southern gold field.

The Northern gold field is situated chiefly on the west side of the Cape Colville peninsula, but gold has also been obtained in small quantities on the eastern side. The peninsula is a bold mountain ridge, having a mean altitude of 2000 feet above the sea level, composed of slate rocks interbedded with the eruptive rocks belonging to the Diorite series of the lower Secondary period. These rocks form at least three well-defined belts crossing the peninsula obliquely in a north-east direction, the depressions which separate them being occupied by tufaceous deposits of volcanic ash, intermixed with ejected fragments of rocks of various ages. These Tufas which envelope the older rocks to an altitude of at least 1400 feet above the sea level, were deposited in the Tertiary epoch, and form part of a formation that occupies a very extensive area in the Auckland province.

The district as yet tested by the miners is a very insignificant portion of the whole area of the country, and the auriferous reefs which have been discovered, are confined to a few isolated localities, in which the tufa presents a very marked difference from its prevailing character, being a fine-grained rock containing a large quantity of auriferous pyrites (Bisulphide of Iron) dispersed through its substance in minute grains and imperfect crystals. This rock, which from its proneness to chemical change decomposes freely, and frequently contains Gypsum (Sulphate of Lime), is the characteristic bed-rock of the auriferous lodes at the Thames and Coromandel. In all the auriferous areas Diorite dykes intersect the tufaceous rock, and it is not yet satisfactorily determined whether the auriferous tufas should be considered to form part of the Tertiary volcanic series, or a distinct formation intermediate in age between them and the slate rocks of the district. The auriferous reefs are rarely well defined, and consist chiefly of sub-crystalline quartz in which the gold is found distributed through the compact portions as minute specks, or entangled in a crystalline or dendritic form, where the quartz is open in its texture. On the whole, the reefs appear to be richest in the decomposed rock near the outcrop, which has frequently led to over-sanguine anticipations regarding some of the

mines; but it is well established that the quartz continues to be auriferous after it is traced into the harder undecomposed rock.

The gold contains the proportion of silver which is characteristic of the compound of gold and silver known as Electrum, and is associated with native Arsenic, Sulphides of Copper, Lead, Zinc, Antimony, and other metals, but only in small quantities.

At Coromandel, where mines were first worked in this formation, the lodes have been "proved" to a depth of over 300 feet from the surface, but the best mines at the Thames have, as yet, principally been confined to the decomposed, and comparatively superficial rock. Veins have been discovered and gold obtained at all levels on the ranges, from the sea level to an altitude of 2000 feet. The quantity of gold that has been obtained from some of these quartz reefs is very great, and for considerable distances the quartz has yielded, pretty uniformly, at the rate of 600 oz. per ton. Such reefs are, however, very exceptional. The quartz reefs are not altogether confined to the fine-grained tufa rock, but when in other formations they are not so auriferous. Those in the underlying slate rocks however contain decidedly more gold than the reefs in the overlying Tertiary tufa, which seldom yield appreciable quantities.*

The amount obtained up to the present time (Dec., 1869) is 213,489 oz., only a few hundred ounces of which have probably been obtained as alluvial gold, the remainder having been extracted from the rock matrix by true mining processes.

The development of this mining district must be looked on as hardly commenced, though unless new districts be discovered, the large yield in proportion to the labour employed, which has hitherto characterised the early days of the mines, cannot be expected to continue.

Before proceeding to describe the second group of gold fields I may mention shortly the character of the rock formation near Wellington, which is the only other locality in the North Island where gold has been obtained in appreciable quantities, though not as yet sufficient to entitle it to rank as a gold field.

The locality where the gold has been obtained is about twelve miles west of the City of Wellington, near Cape Terawiti, where the country is composed of abrupt ridges of Primary slates, shales, and sandstones; with intervening valleys, some of which are occupied by marine tertiary strata. The older rocks belong to two distinct periods, and though both are found generally in a vertical position, the line of junction between them is well marked. The district has been traversed by a series of dislocations, which cross the lines of stratification in oblique lines. The consequent displacement appears to have indurated the sandstones, and altered the shales, when in contact with them, into friable cherty slates of a deep blue colour, traversed by thread-like veins of quartz. The altered sandstone is slightly micaceous, and has been so infiltrated with silica, that hand specimens have been mistaken for granite.

Near these altered patches of rock, a small quantity of fine-grained but rough unworn gold is generally found, the total quantity obtained having been about eighty ounces. Well-defined reefs of quartz also occur in the district, especially in the sandstones, but none of these have yet proved auriferous, on being tested, and the evidence seems to indicate the veins in the blue cherty slate, as the probable source of the gold.

Nelson and Westland, or Western Gold Fields.

In this district, which extends along the west coast of the South Island, for the northern half of its extent, the gold fields are situated on the western

* For full particulars respecting these mines, see Report by Captain Hutton, "Geological Survey of New Zealand," 1869.

slope of the main range of the Island. The alluvial diggings at Collingwood were first discovered in this district in 1858, and in 1864 the great gold fields near Hokitika, attracted the majority of the mining population of New Zealand. Since then the field has been gradually but thoroughly explored, and more or less gold obtained in almost every part of it. The mode of occurrence of the gold admits of very simple classification dependent on the physical features of the country.

The Southern Alps which are near to the West Coast, in the latitude of Mount Cook, are continued northwards through Nelson province to Cook's Straits, by the Spencer Mountains, forming a well-marked range, that defines the head waters of the streams flowing to the east, and is characterised by the line of eruption of the Mesozoic Diorites. The towns of Nelson and Hokitika are, according to this view, equally situated on the west side of the mountains; and between Blind Bay, at Nelson, and the west coast at Hokitika, a well-marked depression extends in a S.W. direction for one hundred and forty miles, separating the central range from a triangular area of mountain country, that has its northern termination at Cape Farewell, and its southern one at the Grey river. This latter district is extremely rugged, and displays a greater variety in its geological structure, than any other part of New Zealand.

Frequent changes in the formation are common in this area, from Hornblende rocks to Schist and Clay slates, while the summits of the mountains are frequently capped with outliers of the upper Secondary coal formation and marine limestones; while in the majority of the streams that radiate from it, gold is found under such circumstances as to indicate that auriferous lodes occur in rocks throughout the district. A few quartz reefs have already been discovered, such as at Moonlight Creek on the Grey river, and Waimongaroa near the Buller, and at Wangapeka and Collingwood, in the north; but as a mining field it is still practically undeveloped. The alluvial gold has, on the other hand, been very extensively worked, the yield up to the present time amounting to 2,235,591 oz. The alluvial gold occurs in well-defined "leads," of which there are three distinct kinds, without including the local "sluicing" diggings in the valleys of the mountain torrents, already alluded to, as generally distributed throughout the area. Unlike the gold drifts of Otago, which rest on the denuded surface of their parent rocks, the auriferous gravels in the western district, as a general rule, rest on the surface of recent Tertiary rocks, of marine origin, having, in fact, been carried out of the mountains by the rivers, and deposited along a gradually changing coast line. They thus have a general distribution parallel to whatever was the western shore of the island at the time of their deposit.

The earliest formed, and most elevated of these "leads," extend in a N.E. direction, from near Ross, where they are cut off obliquely by the sea coast, into the Nelson province, running parallel with the main range, and have already been traced as far as the high terraces near the source of the Little Grey river. They have here their greatest altitude, though still resting on the marine strata, and slope steadily to the south, till at Ross the main lead is actually beneath the present sea level, and worked by true "deep sinking." These leads have been intersected by the more modern streams, and a second class of leads thereby formed; while the third class of alluvial workings is formed by the ancient and modern sea beaches, along which the gold has been drifted by the action of the waves and surf. These workings extend for more than two hundred miles along the coast, and as they are undergoing constant renewal they will afford a permanent source of employment.

The peculiarity of the Westland alluvial diggings that requires to be most impressed on the mind, is that, in the majority of cases, the streams have cut

their channels much below the surface of the country, leaving the richest leads in positions very inaccessible to the water supply required for mining, without adopting a thoroughly organized system of irrigation, so that notwithstanding the reputation of the West Coast as having almost the largest rainfall in temperate regions, the gold fields there are actually languishing for want of the supply of water so essential for gold washing.

Otago, or Southern Gold Fields.

The most extensive alluvial diggings in New Zealand are in this district, and they possess peculiarities that distinguish them from most other gold fields. Notwithstanding the large quantities of alluvial gold that has been obtained in Otago, amounting to 2,548,999 oz., the actual mining operations for the extraction of gold from the matrix, have, up to the present time, been comparatively insignificant.

The gold fields may be divided into two districts. In the eastern district of the province the surface is undulating, and without being mountainous, has a general elevation ranging from 1000 to 4000 feet. The prevailing rock in this district is a very soft mica and chlorite schist cut by vertical joints, and traversed by horizontal laminæ of quartz. The undulations of the surface, as a rule, lie in a direction parallel with the east coast, and each ridge appears to consist of a mass of the schist formation that has been tilted along its western boundary, after the deposit of the Brown coal series (Miocene). A succession of trough-shaped valleys are thus passed over in travelling from the east coast into the interior, along the western side of each of which the Brown coal is generally found to dip under very heavy deposits of alluvial gravels.

The leading features of a section through this part of the province are roughly shown in the accompanying diagram. A B C D are the successive valleys, with the intervening ridges, the most easterly of which shows the Brown coal

formation, capped with Dolerite *d*, as at Saddle hill, and the others represent Maungatua, Roughridge, and the Dunstan ranges, respectively; *a* Schistose rocks; *b* Brown coal formation; *c* Auriferous alluvium.

Besides the quartz in a laminated form, veins of auriferous quartz exist, and, as a rule, are situated along the lines that mark the lines of uplift of the ranges, or in the positions marked by 1 2 and 3 in the above section, and therefore on the west side of each of the ranges. These are not however to be considered as quartz veins, in the sense in which the term is commonly used in Victoria, and cannot be looked on as the only source from which most of the gold in the Otago drifts has been derived.

One of these reefs has been mined at Waipori and yielded an average of one ounce per ton. Other reefs have been recently opened in the western slope of the Dunstan ranges (3 in section), the results already obtained from which promise much higher returns.

No granite or Diorite dykes are known to exist in this eastern district.

In the western, or Wakatipu Lake district, we find a much greater variety of rock formation. The mountains are lofty and abrupt, and are cut into sharp

ridges and peaks, due partly to the unequal manner in which the different kinds of rocks have resisted denudation, but we must also take into account the effect of great dislocations which appear to have affected this district at a late geological period, for we find at considerable altitudes masses of Tertiary Limestone that are unknown at the same elevation in the eastern district. The schist rocks in this western district are less uniformly foliated than we find them in the east. They also afford a much greater variety of minerals, and even become truly crystalline, in son e instances, where dyke rocks intersect them, so that the district may be compared to the north-west district of Nelson.

Several quartz reefs have been mined in this district, on the Shotover and Arrow rivers, and much expensive machinery carried into very inaccessible positions, but these adventures have not proved so successful as was anticipated. However they were commenced at the time the great exodus of diggers took place to the western gold fields, which may account for the reefing capabilities of the country not being better explored. Judging from its geological structure the north-western district of Otago is the most likely part of the province for the occurrence of mineral lodes.

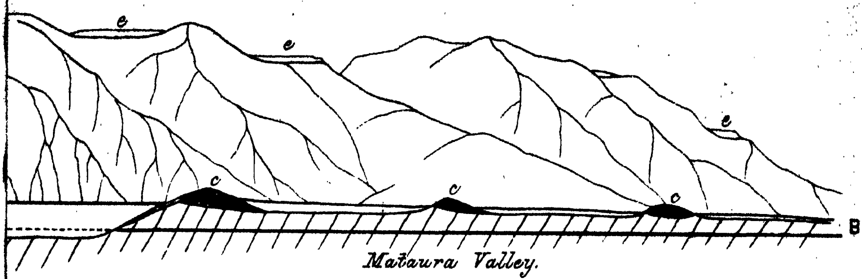
Before leaving the subject of our gold fields, the general mode of the distribution of the alluvial deposits in New Zealand deserves a further description. This subject is important, as most of the mineral wealth, hitherto obtained, has been from this class of deposits, which is generally associated with iron-ore dust or sand, the black sand of the miners, so that these minerals may be considered together. The source of these, like all other sands, is from the disintegration of a parent rock, and together with the other elements of the rock, they constitute what is known as "drift." Gold drift consists of sand and gravel containing gold, and is formed by the action of running water in streams, or water in motion, as along a sea or lake beach. The same action causes the re-assortment of the materials, so that the heavier particles become separated from the lighter, and it must be borne in mind that no other agent than water in motion can exercise this sorting influence. It is therefore not merely the existence of auriferous rocks at the surface in a district which determines the extent and richness of the alluvial diggings, but we must also take into account the amount of disintegration of these rocks, and also the degree of concentration to which the detritus has been subjected. As might be expected, alluvial gold is found to vary in composition according to the nature of the rock which formed the original matrix; thus in Otago the gold is pure or only alloyed with a little copper; at Whakamarina, silver appears in the proportion of 7 per cent., while on this side of the Strait it contains double that proportion; and in the north, at Auckland, though the alluvial gold does not contain the same proportion of alloy, as that obtained from the reefs, which is a circumstance that has been remarked on all gold fields, still it is less pure, as a general rule, than the gold from the above-mentioned localities.

In the South, the gold is associated on the other hand with platina, zircons and garnets, and in the Nelson province with the rare mineral, Osmiridium. In like manner the iron sand varies in composition. In the neighbourhood of basaltic rocks, as at Dunedin, it contains 75 per cent. of titanite of iron, which is a refractory compound of the oxides of titanium and iron, while in some parts of the interior of Otago the sands consist either of magnetite or lodestone, or of hæmatite, both of which are pure oxides of iron and more valuable as ores. On the West Coast the sand has also the latter character, and it is worthy of remark that, notwithstanding its proximity to volcanic rocks. The well-known Taranaki iron sand, from its containing only 8 per cent. of titanic iron, apparently belongs to the sands derived from the older rocks principally syenites and altered greenstone slates.

The distribution of these sands, according to the size of their particles, is very instructive, the deposits being of two kinds—beach formed and river formed. The former are principally on the West Coast, both gold and iron sand being of very fine grain. The greatest altitude at which any beach gold has been found is about 125 feet above the sea, at Watchman's terrace, north of the Grey river. It is found everywhere from Cape Farewell to Jackson's Bay, the richest deposit being at Okarita, about the centre of the great Westland Bight. The coast line south of this does not favour the deposit of fine gold, having bold rocky shores and headlands. On the sandy beaches of the south and east coasts of Otago auriferous sand again appears, and has been found as far north on the East Coast as the commencement of the shingle formation of the Canterbury Plains.

In the North Island the great iron sand deposits have their maximum at Taranaki, but extend north and south of that place, rarely being found at a greater altitude than ninety to one hundred feet above the present sea level, though small quantities can be found in nearly every stream, except where flowing wholly within marine tertiary rocks. No gold has as yet been found with any of these deposits in the North Island. The river-formed deposits of gold of the interior of the South Island are divided into three groups, according to their position and the manner they are worked. The oldest drifts are deposits at high levels, out of reach of the present drainage system of the country, so that they can only be worked by bringing water to bear upon them by a system of "fluming." In Otago such terraces have formed the source of the bulk of the alluvial gold obtained from rich diggings of the second class, which are marginal deposits of rivers and streams, or shallow alluvial flats. Gabriel's Gully is one instance of this, as at the Blue Spur, between Gabriel's and Monro's gullies we find a patch of the high level older drift that has been tapped and sluiced down the bed of a modern stream which concentrated the gold. The remaining form of alluvial gold is that liberated by streams which are excavating rocky beds, but the amount is very insignificant compared to that obtained in Victoria with this form of mining. The quantity of gold got by shallow sinking on false bottoms in Otago, has naturally led miners to expect that deep leads will be found to rest on the true rock bottom. This subject requires a rigid enquiry into the causes which have operated in producing the surface features of the country.

We see, as previously stated, that in the West Coast district, a stratum of auriferous alluvium is found to slope to the south from the Nelson province, until at Ross it forms a true deep lead, being worked by underground mines that are below the sea level, and are kept dry only by pumping. But the basins in Otago are very different in character, being deep depressions in the rock which have no outlet at the present time, except through rocky gorges. These basins have been, to some extent, moulded in their form by a previous extension of the glaciers, during the great Pleistocene elevation of the New Zealand area; but the depressions being partly occupied by Brown coal and other Tertiary strata, proves that they are of much higher antiquity than that period, and that the original inequalities are due to dislocations. But, at the same time, there is no question that the glaciers have been the most active agents in breaking up the surface rocks, and filling the depressions with the auriferous alluvium. This is especially evident in the western district, where the glaciers are still at work, and where the valleys which they occupied during their previous greater extension have not been filled up, but are now occupied by lakes. We have, in these cases, an opportunity of examining the configuration of the valleys by means of the sounding line, and Plate 19, which is a map and a diagramatic section of the N.W. district of Otago, between the Wakatipu lake and the West Coast, will assist in making clear the nature of



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these lake basins, and the relation of the interior lakes to the Sounds on the West Coast.

The section, the general position of which is shown on the map by the dotted line A to B, has been carried over a higher range of mountains than actually occurs in this line, for the purpose of showing the manner in which the glaciers have excavated the valleys, and rather represents a former than the present condition of that particular part of the range. The dark patches on the map represent a few only of the moraines that are shown on the original map which is in the Otago Museum, and which gives the full details of the Pleistocene geology of this interesting district.

The Wakatipu lake, which is fifty-two miles in length and two to three miles in width, lies, in its upper part, between the Schistose rocks on the east, and the upper Palæozoic rocks on the west, so that it marks the junction of two formations. Its surface is 1070 feet above the sea level, which is exceeded by its depth, for it has been found by soundings to vary from 1170 to 1296 feet, the bottom of the lake being nearly level from side to side, and from end to end. The waters of the lake, at the present time, escape over a rocky fall at Frankton, which is almost the middle of its eastern side, but from the lower end of the lake, at Kingston, a broad valley can be traced to the south, joining that of the Mataura river, which, at first sight, appears to have been the former outlet. The lake is fringed by terraces showing the gradual shrinking of its area, as the level of its outfall has been lowered. The only apparent barriers, in the direction of the Mataura valley, is a great moraine accumulation at Kingston, elevated 270 feet above the level of the lake; but on following down the Mataura river it is found to run over a rocky channel, and to cut its way through a gorge at an altitude of 700 feet above the sea, so that even were the Kingston barrier removed, the lake would not be completely drained in that direction. The lake is therefore contained in a rock basin, and not formed by the simple damming up of a valley.

On the western side of the range, within a distance of thirty to forty miles, we have, on the other hand, a series of arms of the sea occupying exactly similar excavations, frequently 1800 feet beneath the sea level. McKerrow lake is an example of one of these, the exit of which has been barred by coast drift covering a moraine like that barring the lower end of the Wakatipu lake, at Kingston. The outlet of McKerrow lake is by the Kaduku river, which is a tidal river, so that the surface of the lake is at the sea level; yet its waters, which are quite fresh, have a depth of at least 470 feet. Milford Sound, which is also shown on the map, twelve miles further south, has a depth, at its upper part, of 1270 feet, but across its entrance the depth is only 130 feet, while the mountains surrounding it rise to 6000 and 9000 feet.

All the valleys on both slopes of the range are occupied by glacier moraines, and although it is only in the higher cluster of mountains that we now find glaciers to exist, there is no want of evidence of their former greater extension.

The section will explain the operation of glaciers in excavating valleys: *a a* represents an area of the mountain top, which is above the altitude of perpetual congelation, and from which therefore the snow deposited can only escape by assuming the form of ice, descending by its weight as a glacier *b* through the valleys to the point at which it melts, owing to the increased temperature counterbalancing the supply of ice. At this point it deposits its moraine or rubbish heaps *c*, and moraines found further down the valleys are sure indications of the glacier having had formerly a greater extent. At the point where the ice descends from the plateau *a* to the glacier *b*, it is generally an abrupt fall, known as the "ice cascade," and it is at this point that the chief amount of erosion takes place, by which the valleys are eaten back into

the plateau in the lines of least resistance, so that the plateau is at last cut up into sharp ridges and peaks, on which snow can no longer rest in quantity to maintain the glaciers, which consequently disappear, leaving only the moraines to mark the successive steps of the process. This is however quite insufficient to explain the origin of the deep excavations in the hard rock, as above described, and the difference in the amount of the excavation on the opposite sides of the axis, irrespective of the character of the rock excavated, (which is in fact the most resisting in its character on that side where the excavation has been apparently the deepest) points to an unequal subsidence as the origin of these basins. This subsidence has been most rapid in the central and western part of the range, so that in the case of a long valley, like that occupied by the Wakatipu lake, the slope became gradually reversed, and what was at first the higher part of a glacier-excavated valley, has become a depression without an outlet. Gradually this depression is being filled up, by the material brought down by the streams, and carried from the moraines higher up the valleys, as represented by *d* in the section; but this material cannot, especially where resting on the rocky floor of the valley, have been subjected to the action of running water after it has been deposited in the still waters of the lake, and therefore fails in one of the essential processes for the formation of auriferous leads, namely, the concentration of the gold from the lighter particles of the detritus.

From these considerations it is evident that it is only round the margins of rock basins, or in positions above the level of the notch in the margin over which the water escapes, that we can expect to find auriferous leads.

High on the eastern slopes of the mountains, in the position marked *e* on the section, are found patches of gravels belonging to the newer system which drained the mountain range previous to this unequal subsidence, and before the excavation of the deep gorges by the extended glaciers of the Pleistocene period; and the gold in most of the alluvial workings in Otago, can be traced to such patches of older drift.

I will now describe briefly the mines which have been worked in New Zealand for the less precious metals, and mention the localities where "lodes" have been discovered.

The Island of Kawau, where the earliest opened mine is situated, was first purchased by the North British Investment Company, about 1841, as a cattle run. It lies four miles from the main land, thirty-seven miles north of Auckland, is about three and a half, by three and a quarter miles in extent, and, from the Admiralty survey, appears to have an extent of about 5200 acres. The island consists of slate rocks which form two principal masses of high land, separated by an E. and W. depression, partly occupied by Bon Accord harbour, and continued eastward by several valleys with wide alluvial bottoms. In each of these masses hills rise from 500 feet to 600 feet altitude, the summits marking the outcrop of mineral veins in most cases. The strike of the older rocks is very varied in direction, but ranges between N.E. and N.W. The dip has a prevailing westerly direction, generally at a high angle. All these rocks are, however, cut by cleavage veins and faults, that give them a false trend to N. 320° E. In this line lie the mineral lodes, and "belts" of mineralized rock, four of which are known.

The first discovery was made at Manganese Point, where the lode shows as follows:—

a. Soft decomposing slate.
b. Red jasparoid slate, encircled with iron and manganese.
c. Soft red rock containing the same ores.
d. Hornstone.
e. Blue slates.

From the beds *b.* and *c.* a quantity of ore was excavated and shipped to London, where it was sold for £7 per ton.

Within a few months a copper lode was accidentally found cropping out, a large sample of which, taken at random, realized £15 to £20 per ton. This led to regular mining operations, and in 1846 a well-defined lode of copper ore was opened up, twelve feet in width, running N.E. and S.W., with a dip or underlay, of three feet to the fathom. The ore consisted of blue and yellow sulphurets, containing an average of twelve per cent. of copper. Several shipments of the ore were made, in the raw state, but had to be abandoned on account of the danger of fire, from the heat generated by the decomposition which the ore underwent in the holds of the vessels.

Works were then erected for the reduction of the crude ore to the state of *regulus*, by roasting, in which condition it was a safe article for shipment.

The situation of the smelting works, which were most expensively constructed, was in Bon Accord harbour, where there is deep water close to the wharves.

The first four years workings realized upwards of £60,000, but the pumping machinery was deficient, so that the mine had to be abandoned for eighteen months, till a large Cornish engine was obtained. This effectually kept the water down, and the mine was extended to a vertical depth of 35 fathoms, with a horizontal extent of 150 fathoms, on a lode averaging 6 feet in width, and consisting of a massive gangue that contained thirty per cent. of copper ore, and the same of iron ore, intermixed with dark green chloritic clay. The lode lies between green slates, containing grains of metallic copper, and stained with salts of copper, and a hanging wall of indurated chert.

The mine appears never to have been worked out, but was abandoned, partly owing to complications respecting the proprietorship, but mainly owing to the superior attractions of the Californian and Australian gold fields at that time. The particular lode that was worked is on a headland on the south side of the island. It was lost in tracing it inland, to the north, but there is good reason to believe that this headland is only a dislocated mass, formed more in the manner of a landslip than a structural fault, and that there may have been a displacement of the lode.*

The Great Barrier Island, on which have been the most extensive copper mining works in New Zealand, is about twenty-four miles long. A central chain runs through the island, throwing off spurs on either side, rising to an extreme elevation of 2330 feet, and maintaining an average height of about a thousand feet throughout its length.

The greater part of the island is composed of volcanic (Trachytic) rocks, resting on sub-metamorphic slates and sandstones, of the same kind as at Kawau. These slaty rocks are, in several places, but especially at Mine Bay, cut by intrusive dykes of quartz porphyry, consisting of a felspathic paste containing grains of fine quartz. Felstone, which may be considered as the same rock devoid of quartz, Diorite, which is a mixture of Felspar and the fusible mineral Hornblende, and, lastly, a true dyke granite, containing quartz, Mica and Felspar. In these rocks we have representations of the crystalline metamorphic formations, which are so abundant in the South Island, brought to the surface as dykes.

Captain Hutton thus describes the position of the mines [*Geological Reports*, 1869, p. 4]:—

"Some of the dykes of Diorite and Felstone contain, near Mine Bay,

* See "Geological Reports, 1869," p. 45, for map, and description of Kawau, by author.

copper pyrites, peacock copper, blue and green carbonates of copper, black oxide of copper, native copper, galena, Dufrénoysite and iron pyrites, but not in large quantities.

"The lode which has been worked for copper for some time at Mine Bay, and which now goes by the name of the 'Otea Company's Copper Mine,' is an old fissure in the slate rocks, filled up with angular debris of slate and diorite of all sizes, from that of a walnut or less, to blocks weighing more than a ton. These blocks are cemented together by a matrix that is sometimes siliceous, and at others felspathic, and it is in this cement or matrix that the copper ore occurs. No lead is found in this lode.

"The fissure runs in a nearly north and south direction across the neck of the small peninsula called Miner's Head. This neck is about 200 yards across. The lode is about 25 feet in breadth at the adit level, which is only a few feet above the sea, and expands to about 40 feet at 14 fathoms above adit, and this breadth it keeps pretty regularly until it reaches the top of the hill in which it is situated, and which I estimate to be about 200 feet above adit. I was informed by one of the miners who helped to sink the shaft, that at 12 fathoms below adit the lode was only 9 feet through; it is therefore probable that the fissure dies out altogether at about 20 fathoms below adit. It is, of course, possible that this fissure may be continued downwards indefinitely; but there is no evidence of a fault or slide having taken place, and the facts of its original gaping character, and its constantly decreasing breadth as it gets deeper, incline me to the opinion that it is merely a superficial crack. The fact of the lode containing blocks of diorite shows that the dykes were in existence before the fissure was formed, and that therefore they are not the cause of the lode being charged with copper."

The mine was first worked in 1845, by Messrs. Abercrombie and Sydney; the ore being a bright yellow sulphide, containing fifteen to sixteen per cent. of metallic copper. The first proprietors worked it for several years, and were then succeeded by Messrs. Whittaker and Heale; then by Messrs. Ninnis and Rowe; and lastly by the Great Barrier Company. The works were then suspended, in 1861, but in 1867 they were again reopened by the Otea Copper Mining Company.

The total quantity of ore mined has been 2,323 tons, the aggregate sales realizing upwards of £30,000. In order to get this ore, Captain Hutton estimates that about 3200 cubic fathoms of vein-stuff have been excavated, which would give a yield of nearly three-quarters of a ton of ore to the cubic fathom; and that about 3800 cubic fathoms remain t. be got above the present adit, which will probably yield 2900 tons of ore dressed to fifteen per cent. If my opinion as to the lode dying out about twenty fathoms below adit be correct, it will follow that not more than 4000 cubic fathoms can be got in this direction, which would yield about 3000 tons of ore, making a total of about 5900 tons of ore still remaining in the mine.

Copper ore was also discovered at Whangapara, in a more northerly locality of the same island, but no regular mine was opened there.

Nine miles north of Mongonui, in the promontory that forms the northern boundary of Doubtless Bay, copper was discovered, and partly worked, by Mr. Brodie, about the year 1849.

The peninsula consists, in great part, of porphyritic Trachyte, and Diorite slates. At the copper mine the cliffs are 300 feet high, and the few confined bays at their base are almost inaccessible.

Here a mass of Breccia Conglomerate abuts against a dyke of hard black Diorite. The Breccia consists of a chloritic matrix, with carbonite of lime, and contains large blocks of Trachyte, and quartz Porphyry. Interspersed are masses of sulphide of iron and copper, and also pure metallic copper. "Cop-

per-green," from the decomposition of these, forms a broad green mark on the cliffs, which first attracted attention from the sea.

The next copper mining adventure to be mentioned is that of the Dun Mountain Mining Company, and for the collection of some of the information concerning it I am indebted to my late assistant, Mr. T. R. Hacket, who came to New Zealand, originally, as Mining Manager to that Company.

Along the east side of Blind Bay, extending S.W. from D'Urville Island, is a line of bare brown hills, which are characterised by low scrubby vegetation, that contrasts with the surrounding green of the forests. These mark what is known as the "Mineral belt," and their singular barren appearance is due to the large proportion of Magnesia which is mixed with the soil that is derived from the rocks which compose them.

The section of the hills between Nelson and the Mineral range, shows that these magnesian rocks occur in the upper part of the Triassic formation,—the lower part consisting of slates, limestones, and indurated sandstones, containing Triassic fossils, passing, in an ascending series, to Diabase rock and Breccia, associated with Diorite and other dykes. In this part of the formation, metallic ores of copper and chrome occur, not as distinct lodes, but as lenticular masses and nests. Dun Mountain, which is the best known locality, is composed of a peculiar mineral, named *Dunite* by Professor Hochstetter, which has the same composition as Olivine, a mineral generally found in basaltic lavas. This rock appears at the surface as a large mass, several miles in extent. It is speckled with chromic iron, very much in the same manner as garnets occur in schistose rocks; but the principal deposit of ore is in a band of Serpentine, lying to the east of the Dunite, and between it and a band of limestones. The Serpentine is traversed by dykes of Felstone and Diallage, and a great variety of other minerals—the district being certainly the most interesting locality in New Zealand to a mineralogist.

Copper, associated with Specular iron, was first discovered in 1853, and occurs in the metallic form, and also a red, gray, and blue oxide, but in small quantities, about thirty tons only having been excavated.

The chrome ore forms wedge-shaped masses in the Serpentine, which vary in thickness, from a few inches to as much as twelve feet. The ore is crystalline in its texture, generally pure, but occasionally traversed by thin streaks of Serpentine. The veins are generally discovered cropping out at the surface for a few fathoms in parallel lines, but never form continuous lodes.

Chromic iron which is chiefly used for making dye stuffs, contains about forty-five per cent. of chromium, and was worth, before the discovery of the Analine dyes, £10 10s. per ton. 5000 tons have been raised, and the veins already opened expose an estimated quantity of 10,000 tons. The mines, which are at an altitude of 2500 feet above the sea, have been connected with the Port of Nelson by a line of railway 12½ miles in length, and having a gradient in a great part of its course, of one in eighteen. The shipments of the ore amount to 4500 tons, which are delivered in London at a cost of £3 13s. per ton.

On the same belt of mineral ground as the Dnn Mountain, several other mines have been opened, in a line extending for fifteen miles, but ore has only been shipped from three of these mines, which possess the same general character as the Dun Mountain mine, without however, the occurrence of the Dunite or some of the other minerals, which might otherwise have been supposed to be necessary accompaniments of the metallic ores. I may mention that the only other place in New Zealand where Dunite has been discovered, besides the Dun Mountain, is at Milford Sound, where it also contains chromic iron, and passes into jade or Maori greenstone.

At Anniseed Valley mine, a few miles south of the Dun Mountain, which

was discovered in 1861, the chrome ore is in serpentinous schists, between a mass of Elvenite with copper, on the west, and a band of limestone on the east; while Black Reef, and Ben Nevis mine, still further south, occur in tough green serpentine. All the mines would yield a large supply of the chrome ore, if there was any demand for it, but they are very difficult of access.

At the northern termination of the mineral belt, a few small copper veins have been discovered, at Croixelles Harbour, and D'Urville Island, the ore, as at Dun Mountain, occurring in small nests in Serpentine and Hornblende schist.

There are two more copper lodes to be noticed, but neither of which have yet been worked. They are both in the Province of Otago, and the ore is Sulphide of Copper, occurring in the metamorphic schists. This first is at Moke Creek, near the Wakatipu Lake, where the lode is about four feet in width. Limestone and wood are found in the neighbourhood, and by reducing the ore to a regulus, containing sixty per cent. of the metal instead of twenty, which is the average of the crude ore, it might be worked with advantage if the land carriage were improved, notwithstanding its distance from the coast.

The second lode, at Waipori, near Tuapeka, has only been imperfectly explored, but it appears to be similar to that at Moke Creek. I will only enumerate a few of the indications which have been observed elsewhere of the occurrence of other ores, as no other mineral lodes have been explored besides those I have mentioned. Thus we have silver lead ore in the Wangapeka river in Nelson; red copper ore in Bligh Sound, on the West Coast, and Magnetic iron ore of Otago; and lastly, I must not omit to mention the Manganese veins which have been worked in the island of Pakihi, near Auckland, an account of the geology of which is given by Captain Hutton in the first volume of our Transactions; nor the rich lode of the same ore which is found at Tikiora at the Bay of Islands.

Coal Fields.

The classification of the coal deposits of New Zealand is founded partly on geological age, but chiefly on the chemical composition of the coal. Besides the tertiary lignites, there are two coal formations, both of which, as I have already mentioned, belong to a period which is equivalent to the Upper Secondary and Older Tertiary strata of Europe. All the thickest seams of coal yet found, are in the upper formation. The coal is of two varieties, the one containing a large quantity of water in its compositon being inferior; while the other is a dry coal, and of value equal to the best that is ever imported from Australia.

Coal mines have been opened in every Province of the Colony, but the space at my disposal only permits of my mentioning a few of the chief localities where coal is being actually worked. I commence with the Kawa kawa mine, at the Bay of Islands, from which coal is at the present time being excavated at the rate of about 1500 tons per month, chiefly for the supply of the Thames Gold Fields. This valuable seam was originally discovered in 1863, by Maoris, when digging for Kauri gum, but it was not systematically worked for several years after that date. The seam is from ten to sixteen feet thick, and occurs at the base of a Green sand formation, that crops out not only at Kawa kawa, but so far south as Wanganui, and at intermediate localities, so that its extent is very considerable. The coal is now excavated by a drive into the side of the hill where it was first found, but for a long time it was worked by a shaft sunk on the outcrop of the seam. A tramway has been made for three and a half miles, to convey the coal to a point on the river where it can be

placed in barges which take it down to deep water. Notwithstanding the extra expense arising from repeated handling of the coal, it is delivered alongside the colliers at 14s. per ton. The coal, when carefully selected, has very powerful heating qualities, and burns with a rich gaseous flame. It has been repeatedly tested, and favourably reported on, by steam vessels, and its only drawback is that it is friable, and is frequently shipped without the impurities containing sulphur having been removed by screening. At Wangarei small colliers can ascend to the point above where the tramway terminates, so that coal is put on board for 13s. per ton. The coal is however very different in its quality from that at Kawa kawa, notwithstanding that it appears to be either the same or an equivalent seam in the same geological formation, having a larger proportion of ash and water, and a corresponding deficiency of gaseous matters.

Twenty miles south of Auckland, coal mines have been worked for many years near Drury, where there is an extensive coal field. According to Professor Hochstetter there is only one seam, having an average thickness of six feet. The quality of the coal is that of common Brown coal with over 20 per cent. of combined water, but from its containing large quantities of fossil resin, it proves a very valuable fuel.

On the Waikato river there is a still larger extent of the same coal formation, containing one principal coal seam which is eight to twelve feet thick. Captain Hutton is of opinion, as the result of careful survey, that in this field there is about 140,000,000 tons of coal available, without pumping or mechanical appliances for raising the coal.* This coal is extensively mined for supplying the steamers that ply on the Waikato river, and answers well for that purpose.

There are no other coal mines in the North Island except those above mentioned, but in the district between the Mokau and the Wanganui rivers, there are extensive coal seams, and also from near the East Cape, on the opposite side of the Island, samples of coal of very superior quality have been obtained.

On the west coast of the Province of Nelson, there are several distinct coal fields, the most northerly of which, termed the Pakawau field, is about thirty square miles in extent. The coal occurs as several seams, none yet found exceeding four feet in thickness, at the base of a sandstone and shale formation 1500 feet thick. Mines have been opened at Pakawau, and Collingwood in Golden Bay, and in the beautiful little harbour of West Wanganui, on the West Coast. The coal varies in quality, but is, on the whole, more valuable than that found in the northern fields. The quantity of coal raised from this district has not been great, as the best seams are in rather inaccessible positions, but if they are opened up with caution and proper economy, there is no reason why they should not prove remunerative.

In connection with this coal field, I should mention the deposit of Plumbago or Black Lead, which has been mined to a small extent near Collingwood, as it is probably derived from an altered portion of a coal seam. The Plumbago is, however, of good marketable quality, seven tons exported in the manufactured form, having an approximate value of £1400.†

The Buller coal field occupies a narrow strip along the coast north of the Buller river, forty miles in length and seven in width, and is peculiar from the great elevation at which it occurs. The formation consists of quartzose grits, 200 to 300 feet thick, with a single seam of very pure coal, ten feet thick, near

* See "Geological Report on the Lower Waikato District," by Captain Hutton, p. 4.

† For comparative value of this Plumbago, see "Juror's Rept. N. Z. Exhibition, 1865," p. 417.

DDD

the base of the formation, which rests on the top of a range of mountains from two thousand to three thousand feet above the sea level.

The only obstacle to the working of this coal is the expensive character of the works required for conveying it to the shipping place; but the Buller river is so much superior as a port, to any other place on the N.W. coast of the Island, that with such coal seams in its neighbourhood, it is certain in time to become one of the chief places from which coal will be exported. The coal is the best in quality of any yet found in New Zealand, and judged of both by chemical analysis and by practical test, compares favourably with the best British Bituminous Coal.

The two fields last mentioned have more a prospective than an immediate value in the present state of the West Coast District; but the development of the Mount Davy coal field will have a practical influence on the resources of the country at the present time.

The area occupied by the coal formation in this instance is not so great as that of either the Pakawau or Mount Rochfort fields; but the value and accessibility of the coal seam gives it a superior importance. The best coal appears to be in one main seam, associated with micaceous sandstone and grits containing plant impressions, and small carbonaceous layers, as seen at the Brunner Mine, in which the coal has been followed on the level for 1100 feet, and likewise explored to the outcrop; the total length of the galleries and chambers being nearly 4000 feet.

The thickness of the seam varies from fifteen to twenty-three feet, and is contained between a roof and floor of solid grit, which enables it to be worked with facility, timbers being required for the support of the roof only in a few places where it had a tendency to flake.

The coal formation rises, at an angle of 12°, in an easterly direction from the water level to an altitude of at least 2000 feet in the Mount Davy Mountains, and extends to the north for a distance of seven miles, intersecting the coast about twelve miles north of the Grey river. (See Map and Section, Plate 14.) Any coal within this area can, of course, be worked "level-free," as in the case of the present mine, which system involves the least possible working expense, all excavations being in marketable coal, and no outlay being required for hauling the coal or draining the mine.

Westward from the mine the coal dips under 1500 feet of strata of sandstone and septaria clays, which are again overlaid by indurated chalk marls, with fossils characteristic of the upper secondary period, principally Echinodermata (Sea-urchins), ten species of which have already been distinguished and figured, and a large Inoceramus. Under a considerable portion of this area, coal will hereafter be worked by shafts; but the coal above the water level will be the first to deserve attention.

To the eastward, we find the coal formation cut off suddenly by a great break or fault, as shown in the section.

The facilities for working the coal on the south, or Canterbury side, are not so great as those at the present mine, but the southern extension of the field in that province is not yet ascertained, and it is probable that even a larger area will prove available for working by shafts on the south than on the north side of the river.

The supply of the coal is not equal to the present demand at the port, being controlled by the defective system of transport from the mine by barges. In the ordinary state of the river, the barges can only take a very small quantity of coal, rarely delivering more than forty or fifty tons a day, and involving a very large expenditure of labour. A survey has been made for a railway from the port to the mine, a distance of seven miles; and, from the favourable nature of the country, this line should not cost more than £20,000

which is a very small outlay, considering that it is the only heavy expenditure required to secure the regular supply of coal.

Provided that no fault occurs in the strata, I see no reason for doubting that on the most moderate computation the portion of the field already leased should yield 5,000,000 tons of coal.

The expenses of working the mine are so small that the coal should be delivered at Greymouth at a very moderate price, if the working were carried on more extensively, and a steady market for the coal established.

The seam of coal is pure and homogeneous, and possesses the property of caking with such facility that the whole quantity excavated can be utilized, so that no labour is unproductive, as is the case in mines where stone bands, shales, and other worthless matter have to be excavated along with the coal.

In the south-west of Otago coal seams occur at the base of a chalk marl and sandstone formation, at Preservation Inlet, which formation appears to be of the same age as that which extends through Southland, and runs out on the coast in the south-east district of Otago, but there the marls are replaced by sandstones and shales, in the same manner as in the Pakawau field. The value of the coal varies in quality in different localities, but is, on the whole, good fuel. An attempt has been made to open a mine at Preservation Inlet, but not much progress has yet been made. At Morley Creek, Waikawa, and other places, the coal is mined, but chiefly for local use.

In the interior of Otago province, lignite is found almost everywhere, except in the Wakatipu Lake district, and mined for the supply of the diggers, who could not carry on their mining operations in the treeless uplands of the Otago gold fields, were it not for mineral fuel being thus widely distributed. On the East Coast several very extensive areas of Brown coal formation occur, from which Dunedin is largely supplied. The largest of these is at Coal Point, near the Clutha river, where the seams have an aggregate thickness of fifty-six feet, and the formation extends over about thirty square miles.

Forty miles north of Dunedin the Upper Secondary coal formation again commences, and, running north, skirts the eastern slope of the mountains in broken patches, being found at several points in the Province of Canterbury, and re-emerging on the coast at Motanau in the Amuri country.

At the Malvern hills coal seams of different qualities, including Anthracite, Bituminous coal, and common Brown coal, have been worked, and the whole series of the Upper Secondary and Tertiary coal formation appear, from the fossils, to be represented. The most extensive mine is in the Brown coal, of which there are several thin seams, that yield about 800 tons a year. The proximity of this coal field to Christchurch, and the fact of coal of very superior quality being found in different parts of it, gives it considerable importance.

Newer basins containing inferior coal also occur along the Canterbury and Nelson mountains as in Otago.

From the foregoing brief outline I think that New Zealand must be considered as, on the whole, well supplied with mineral fuel. Certainly, coal of the most valuable description is confined to limited and not very accessible areas, but still there is nothing to prevent its being profitably worked for the supply of our steam service; but the great point for congratulation is, that throughout almost every part of these Islands, coal of a practically useful description is to be found within a short distance.*

Before concluding this review of the mines of the Colony, I will make a few remarks on the building materials. The number of kinds of stone already

* See "Report on Coals of New Zealand, 1866;" "Abstract Progress Report of Geological Survey of New Zealand, 1867;" "Supplement to Jurors' Report, New Zealand Exhibition, 1865, Art. 'Coals,'" by Author.

worked in New Zealand is very large. They are generally divided into granites, limestones, and sandstones. Of the former, the only quarry is at Adele Island in Blind Bay; but this valuable stone exists in unbounded quantities on the West Coast of Otago, under the most favourable circumstances for excavation and shipment. The variety in colour and grain is also very great. It is not necessary to say anything regarding the quality of granite as a building stone, as it is well-known, and no large erection, especially of a marine character, should be undertaken without employing it. Although not properly belonging to this group, but still allied to it in the manner of quarrying, we have syenites from the Bluff, and Nelson Boulder bank; dolerites and basalts from Port Chalmers, Dunedin, and Lyttelton, and lavas from Auckland.

Of Sandstones—pure siliceous varieties occur with the coal formations. Flagstones are largely used in Nelson, being obtained from the Dun Mountain; they are very applicable to construction in earthquake countries, but the particular kind found at Nelson is defective from its steatitic character preventing the proper adhesion of mortar.

Freestones—abound in the tertiary formation of New Zealand, including sandstone, clay sandstones, and argillaceous sandy limestones and pure limestone. The finest is the now famous Oamaru stone, which possesses characters that excel most ordinary building stones used in other parts of the world, on account of its durability and facility of working, as it is moulded and cut by machinery with even greater ease than wood. The same formation is very extensive, and beds of equal quality will no doubt be found in other localities. It is very easily excavated by making openings in the low round hills near Oamaru. The absence of a good shipping port limits the extensive use of this stone, which would without any doubt become a valuable export. There are no roofing slate mines in New Zealand, but from hand specimens obtained in various parts of the upper Palæozoic rocks, there is no reason to doubt that they exist in several localities, especially in the neighbourhood of Queen Charlotte Sound, and the Wakatipu Lake.

Limestones abound in the tertiary rocks, having sufficient purity and compactness to fit them for burning, and in the older slate rocks there are a few developments of what in a quarryman's sense may be described as mountain limestone, blue compact, sub-crystalline or flaggy. The most accessible places where this limestone occurs is on the north side of Shag valley in Otago, and near the Dun Mountain in Nelson; while at Collingwood massive marbles occur, that might be used for ornamental purposes; cement stones abound in the middle tertiary clays underlying the limestone, and also in more recent clays concretions are found in definite layers which contain almost sufficient lime in their composition to enable them to rank as cements. The Moeraki boulders,—the wonderful size and spherical form of which has attracted the attention of all travellers along the Otago coast—are examples of such concretions which have been formed round a nucleus of organic matter.

Having thus in a very condensed form explained the different mining operations which have been commenced in this country, with the object of showing the extent to which they have been successful, I would remark that all mining involves a certain amount of speculation; and if, so far, the adventures in this colony have not been invariably successful, yet when we consider how very limited and fitful the attempts have been, and the few localities that have been tested, it must be admitted that there is good evidence that New Zealand is endowed with a fair share of mineral wealth. At the same time we should not forget that unless we have a thriving population, minerals will not increase the real progress of the country. Many of the richest mineral producing countries in the world occupy a very inferior position

among nations, and it is only when the development of mineral wealth comes as an accessory to other productive industries, that it is a real advantage to the country, by affording employment for labour and manufacturing ingenuity.

I append two Tables, compiled from official returns; the first showing the amount of Coal which has been imported into the colony, chiefly from New South Wales. This return shows that there is a very large annual expenditure for this item, part of which, at least, might be directed to the development of our own coal fields, if the difficulties of access to the coal seams could be surmounted; and also if the very unfounded prejudice which prevails against the use of the better kinds of Brown coal, for domestic purposes, was overcome.

On the important utility of these coals I will quote the opinion of Professor Hochstetter, who says:—"That those Brown coals,—being as they are, of a nature and quality, far different from English coals,—should, in many instances, be deemed, in New Zealand, far inferior to what they are, is easily accounted for; and years will pass away before the prejudices will be overcome with a people that hitherto have only known and used the excellent coal of their mother country. Time and experience, however, will show, that the Brown coal in New Zealand can be used for the same purposes, for which just the same coal, and sometimes of a far inferior quality, is used on a most extensive scale in various parts of Germany and especially in Austria, in whole provinces of which (Styria, Krain and Northern Bohemia) it constitutes the almost exclusive fuel for manufacturing and railroad, as well as for domestic purposes."—"New Zealand," by Dr. F. von Hochstetter, p. 90.

The second Table shows the quantity of the different metallic ores which has been exported from the colony during each year. This return is necessarily imperfect, especially for the years prior to 1853, at which date the regular publication of the statistics of the colony was commenced. They are however approximately correct, and show the total value of exported minerals, during the past twenty-five years to be £19,652,201.

TABLE I.—Quantity and Value of COAL Imported into New Zealand, from 1853 to 1869, inclusive.

Quantity and Value.	1853	1854	1855	1856	1857	1858	1859	1860	1861	1862
Tons.	1253	2361	4085	3361	3112	5350	20140	16728	25995	34308
£.	4365	8454	10730	7329	8023	13854	43240	37554	59236	84401

Quantity and Value.	1863	1864	1865	1866	1867	1868	1869	Totals.
Tons.	61192	80618	86172	101469	76330	87854	91874	702,202
£.	133241	166255	159160	183846	134705	154628	139941	1,348,962

TABLE II.—EXPORTS from 1853 to 1869, inclusive.

YEAR.	COAL.		COPPER.		IRON.		CHROME ORE.		SILVER.		GOLD.	
	Amount.	Value.	Amount.	Value.	Amount.	Value.	Amount.	Value.	Amount.	Value.	Amount.	Value.
	Tons.	£.	Tons.	£.	Tons.	£.	Tons.	£.	oz.	£.	oz.	£.
1853	41	114	170	1,750	18	254	...	...	...	...	...	...
1854	...	...	302	3,450	9½	137	...	...	...	...	...	...
1855	94	266	140½	3,800	1½	20	...	...	...	...	...	...
1856	...	...	514	11,418	65½	520	...	...	...	...	...	...
1857	3	9	1½	70	...	...	...	...	...	...	10,297	39,904
1858	2	4	351¼	5,000	...	...	3	25	...	...	13,533	52,443
1859	...	...	245	2,605	...	...	8	120	...	...	7,336	28,427
1860	1	2	137	1,590	...	...	116	1,440	...	...	4,538	17,585
1861	...	...	110	1,300	...	...	52	520	...	...	194,234	752,657
1862	...	...	51	1,024	...	...	3,483	24,719	...	...	410,862	1,591,389
1863	...	...	..	...	...	...	595	4,318	...	...	628,646	2,432,479
1864	...	...	...	...	105	52	768	4,910	...	...	479,914	1,855,830
1865	...	...	...	...	...	...	...	...	...	...	574,574	2,252,689
1866	261	400	...	...	...	...	281	1,315	...	...	735,376	2,897,412
1867	973	1,228	246	2,700	...	...	...	...	...	...	686,753	2,724,276
1868	1,027	1,210	84	977	7	80	...	...	...	...	637,474	2,492,793
1869	756	800	7	179	1	3	...	...	11,063	2,993	614,281	2,362,995
Totals ...	3,158	4,033	2,359¼	35,863	207½	1,066	5,306	37,367	11,063	2,993	4,997,818	19,500,879
Approximate return for period prior to 1853	...	...	2,400	70,000	...	...	...	...	...	...	...	...

Notes on the Ornithology of New Zealand.

By Walter Buller, F.L.S., F.G.S.

[The extract from the "Ibis," to which the following paper refers, was communicated to the Wellington Philosophical Society on the 19th June, last; the discussion is a continuation of that commenced in Vol. i. of the "New Zealand Institute Transactions," p. 105. The communication was received too late for insertion in its proper place, in the first section of the "Transactions."—Ed.]

Professor Newton, the editor of "The Ibis," has kindly favoured me with corrected proofs of a paper on New Zealand Birds, forwarded to him by Dr. Otto Finsch, of Bremen, for publication in that journal.

Anything from the pen of so accomplished an ornithologist as Dr. Finsch, cannot fail to be read with delight, and as the paper in question deals particularly with species described by myself as new, it naturally possesses for me a more than ordinary interest.

No one can appreciate more fully than I do the labour and research which Dr. Finsch has bestowed on Polynesian Ornithology generally, contrasting, as it does, with the indifference and neglect with which collections from New Zealand are usually treated by both English and Continental zoologists. Any recognition of their labours, whether in the nature of approval or criticism, is encouraging to local naturalists, who, far removed from the great centres of civilization and learning, and wanting the aid of Libraries and Museums of Natural History, work always at a great disadvantage.

The free discussion of doubtful or disputed points cannot fail to be useful, and I am therefore glad that Dr. Finsch has afforded me an opportunity of further elucidating the subjects treated of in a former paper.

In the article under notice, Dr. Finsch condemns several of my new species, having, as he believes, identified them with forms already known to science. I am quite ready to disclaim the credit of authorship, if it can be conclusively shown that any of my so-called new species are invalid, for I have, in common with Dr. Finsch, but one object in view, namely, the advancement of Ornithological Science. But I have a right to examine the data on which any adverse opinions are founded; and, lest it should appear presumptious in me to combat some of the conclusions of an ornithologist of far greater experience than myself, and one possessing, in the Continental Museums, better opportunities for comparison and research, I would here mention that I enjoy at least one important advantage over the best closet naturalist,—that of being able to make field observations and to study the objects themselves in a state of nature. Dr. Finsch has himself remarked in a former paper (*Journal für Ornith.*, 1867, p. 342) when treating of my *Gerygone assimilis*, "it is difficult, and scarcely safe to decide on this new species from skins alone," and it is moreover probable that in one or two instances he has been unconsciously misled by specimens forwarded to him wrongly named, and purporting to be typical examples of my new species.

I beg to submit the following remarks on Dr. Finsch's paper, which will be found appended hereto, together with the original article (from "The Ibis") which evoked it.

I.—Platycercus alpinus, Buller.

Dr. Finsch disallows this species on the ground that the differences which characterize it are "by no means specific, and only indicate the young bird." Here, at once, we have an illustration of the mistakes into which even the most careful closet naturalists are apt to fall, from a mere comparison of dried specimens. I have obtained the young of *Platycercus auriceps* from the nest, and caged it to maturity. From the first the frontal band and thigh spots were crimson, and the only perceptible change was in the general tints of the plumage. On the other hand, I have known a caged specimen, coloured as in my *P. alpinus*, which was, to my certain knowledge, more than five years old, and in which there was no indication of a change from orange to crimson. It is clear, therefore, that the peculiarities in the coloration of my bird are not attributable to immaturity. But, as already pointed out, there is also a very manifest difference in the size: *P. alpinus* being much smaller than *P. auriceps*, as the latter is less than *P. pacificus*. Apart from this, Dr. Haast (to whom I am indebted for my first examples) writes thus on the habits of the bird:—"I send specimens of both (i.e., the crimson-fronted and the orange-fronted). These two kinds occur always together, but in some localities the first, and in others the second is predominant. You find both kinds in all seasons; therefore we cannot suppose that the orange-fronted is the young of the other. In its habits it is not so bold as the crimson-fronted bird;" and in a subsequent letter he remarks, "the last named species is a much smaller bird than the two former [*P. pacificus* and *P. auriceps*], and its habits are also different."

Admitting that the differences which characterize this bird are constant, and that they are sufficiently obvious to mark a distinct race, my position is established. Whether the aberrant form is to be regarded as a "species" or as a well-defined "variety" in which the distinguishing characters are constant, need not be here discussed, for it at once raises that *quæstio vexata*, "What is a species?" On what I take to be the true definition of a species, *P. alpinus* is clearly entitled to rank as specifically distinct from the other members of the group.

Since the date of my notice in "The Ibis," I have discovered that this bird is not restricted to the South Island exclusively, the caged specimen referred to above having been obtained in the Wellington province. Nevertheless it is extremely rare in the North Island. Nor does it appear to be confined in its range to the higher elevations, and the specific name I have given is perhaps not quite appropriate. It was suggested by the following note from my excellent friend Dr. Haast, who has the credit of the discovery:—"We shot this pretty bird in the Oxford Ranges, and among the forest vegetation in our Alps, at an elevation of 2500 feet.

Dr. Haast's remarks on the peculiar local distribution of *P. auriceps* and *P. alpinus* apply also to the two species that are common in the North Island. *Platycercus auriceps* largely predominates in the northern portions of the Island, and *P. pacificus* in the southern, although both species are to be met with in every district.

II.—Nestor occidentalis, Buller.

Dr. Finsch remarks of two specimens forwarded to him by Dr. Haast, and identified as *Nestor meridionalis*, that they "most probably" represent my new species, because they were obtained from the "same locality," viz.,—the West Coast of the South Island, but Dr. Finsch is perhaps not aware that the region thus indicated is very extensive, ranging through 7 degs. in latitude, for a distance of five hundred miles, and that in limited areas of this district, without doubt, are several birds which have never been found elsewhere.

The only two specimens of this Nestor that I know of (both of which are in my own collection) were obtained in 1863 by Dr. Hector, in a remote part of the West Coast country to which probably no other explorer has ever penetrated. I submit, therefore, that Dr. Finsch's opinion resting on such insufficient data is by no means conclusive.

The following notes from so accurate an observer as Dr. Hector are far more to the purpose, for they contain the evidence of a field naturalist on a very material point :—

"The range of this bird is very limited. It frequents the precipitous wooded cliffs in the neighbourhood, of George Sound. I never met with it in the forests of the low lands. It is more active in its habits and more hawk-like in its flight than the common Nestor. It often sweeps suddenly to the ground; and its cry differs from that of the common Kaka, in being more shrill and wild."

Dr. Haast forwarded me specimens of a large Nestor from the West Coast which he considered new, as it differed consideraby from the typical *Nestor meridionalis.*

After examining these specimens very carefully, I abstained from characterizing the bird as new till I could obtain the opinion of an eminent ornithologist in England, to whom I forwarded examples. His reply has not yet been received, but if Dr. Finsch's remarks apply to this bird, we may consider that it is identical with *Nestor meridionalis.*

Dr. Haast was nevertheless fully impressed with the belief that this bird was distinct from the common species, as will appear from the following interesting notes which accompanied one of his specimens :—"I send you another skin of our Alpine Parrot. Even judging from its habits alone, it is quite distinct from the Common Kaka. It is never found in the Fagus forest, whilst the other never goes above it into the sub-alpine vegetation. Near the glacier sources of the Waimakariri, where I was in the latter part of March, I saw them frequently in the Alpine meadows—4000 to 5000 feet high—feeding on the large red berries of *Coprosma pumila* and *nivalis,* two dwarf plants lying close to the ground. We found these berries in the gullets of those we opened. They evidently had their nests with young ones among the crags of the nearly perpendicular rocky walls (about 6000 feet above the sea), and I repeatedly observed them flying backwards and forwards, as if feeding their young. After the first day's shooting they got exceedingly shy, and could not be approached within gun shot." Mr. Fuller, the taxidermist to the Canterbury Museum, also states, as the result of very careful observation, "that the manner of flight is quite different from that of the common Kaka, for they soar after the manner of the Kea (*Nestor notabilis*).

III.—Gerygone assimilis, Buller.

Dr. Finsch condemns this species, because a specimen received from Dr. Haast, and labelled "*G. assimilis,*" agrees in every respect with "*G flaviventris.*"

I am not aware that I ever met with *Gerygone assimilis* in the South Island. At any rate I demur to being held responsible for wrongly named specimens, which I have never had an opportunity of identifying. I am not surprised that Dr. Finsch, on receiving the *supposed* example of *G. assimilis,* was "at once convinced that the skin of this species is not distinguishable from that of the true *G. flaviventris,*" especially, as he adds that the specimen agrees in every respect with the description and figure given by Mr. Gray—("Voy. Erebus and Terror").

There is an appreciable difference in size between the two species.

IV.—Turnagra Hectori, Buller.

Dr. Finsch is no doubt right in his identification of my bird with *Otagon tanagra*, Schlegel. The description of the species appeared in a German work, in 1865, but without any habitat being assigned to it; and it was noticed in Dr. Günther's "Zoological Record" for the same year; but I believe I am right in stating that no description of it had appeared in English before the publication of my article in "The Ibis."

The genus *Turnagra* was established by M. Lesson, in 1837. Our oldest known species was originally placed by Mr. Gray in his genus *Keropia*, and was distinguished as *K. crassirostris*. The generic title was afterwards altered to *Tanagra*, and again to *Otagon*. But ultimately Mr. Gray referred the species to the genus *Turnagra* ("Gen. of Birds, 1841"), and I have deemed it right to follow his classification. The names *Tanagra capensis*, Sparrm, *T. macularia*, Quoy. and Gaim., and *Otagon turdus*, Bonap., are all synonyms of our well known *T. crassirostris*, the Piopio of the South Island.

Prof. Schlegel has retained Bonaparte's genus Otagon, and adopted the rejected generic title of *Tanagra*, specifically to distinguish the new form. According to our nomenclature this would of course be *Turnagra tanagra*, which appears to me a very objectionable combination.

The merit, however, of being the first to notice the existence of this new species belongs to Prof. Schlegel, although he was apparently unaware that it came from New Zealand. I am quite satisfied in having been instrumental in adding it to our List of Native Birds.

V.—Anas gibberifrons—Müller.

I am under an obligation to Dr. Finsch for setting me right with this species. It is remarkable, however, that a bird known to inhabit Australia, and having so wide a distribution should have been entirely omitted in the recent handbook edition of Mr. Gould's great work on the Birds of Australia. My *Anas gracilis* sinks into a synonym of *A. gibberifrons* which is now added to the list of New Zealand birds.

While on the subject of Ducks I would add that a further addition has been made to our Avifauna in a species from Waikato, sent to me by Captain Hutton, which I have identified as the *Nyroca australis*, Gould. (See ante, p. 78.)

VI.—Podiceps cristatus—Linn.

The example from which I took my original description of *P. Hectori*, did not disclose the white on the secundaries and scapularies, owing probably to the condition of the dried skin; but specimens which I have since received agree with Dr. Finsch's description. My *P. Hectori*, like Gould's *P. australis*, must therefore be held synonymous with *P. cristatus*, Linn. But it is probable that we still have in this country a distinct race of the Crested Grebe, distinguishable by the under parts being of a uniform dark rufous grey, instead of silvery white, stained on the sides with chestnut, as in *P. cristatus*.

I treated this bird as *P. Hectori* in another state of plumage, but I cannot discover that *P. cristatus*, in any condition, presents this peculiarity, which is constant in all specimens from certain localities. Dr. Hector considers this dark-breasted Grebe (of which there are specimens in the Colonial Museum, at Wellington), a distinct bird, and states that it is found on the Wakatipu Lake, accompanied by young, and possessing the double crest and red ruff which characterizes the adult bird; while in brackish lakes by the coast, where old and young birds, and also eggs were obtained, none but white-crested birds were ever shot.

If this dark-breasted bird should hereafter prove to be a distinct species, I must claim from naturalists its recognition as the true *Podiceps Hectori*.

[*Extract from* 'THE IBIS,' *for* SEPTEMBER, 1869.]

Remarks on some Species of Birds from New Zealand. By Dr. O. FINSCH, C.M.Z.S., &c.

IN a large collection of birds which I lately received from Dr. Julius Haast, the well-known explorer of New Zealand, I was very much pleased to find some of the species lately described as new by Mr. Walter Buller, in his 'Essay on the Ornithology of New Zealand*,' or in his paper in 'The Ibis' for the present year (*anteà*, p.p. 37—43). A careful examination showed me at once that some of those so-called new species are by no means new to science; therefore it will, perhaps, be a matter of some interest to the readers of this Journal, as well as to ornithologists in general, to become acquainted with the results of my studies.

PLATYCERCUS ALPINUS, Buller, Ibis, 1869, p. 39.

Two specimens, male and female, from the Southern Alps, and marked as types of Mr. Buller's supposed species, are not distinguishable from the old known *P. auriceps*, Kuhl., either in size or colouring. Mr. Buller characterizes the new species by the orange frontal band, and by the orpiment-orange (instead of crimson) thigh-spots; but these slight differences are by no means specific, and only indicate the young bird. In my Monograph of the family Psittacidae (vol. ii. p. 286) I described such a younger bird, from a specimen in the Bremen Museum, which corresponds in every respect with *P. alpinus*, Buller.

NESTOR MERIDIONALIS, (Gmel.)

Two specimens from the west coast of the South Island, the same locality from which Mr Buller described his new *N. occidentalis* (*suprà*, pp. 40, 41), and most probably belonging to this species, I cannot distinguish from the true *N. meridionalis*. There are slight differences in the shade of their colouring, as well as in their size, but it must be remembered that all the species of *Nestor* vary very much, as I have already remarked in my Monograph, wherein everybody will find a full account of this subject. In any case, *N. occidentalis* needs a more minute description of its distinctive characters before it can be enumerated in the list of so-called good species.

I take this opportunity of adding an interesting notice respecting the systematic place of the genus *Nestor*, which Dr. Haast was kind enough to send me. He writes to me, "Your arrangement of the genus *Nestor* in the system is quite right. These birds are indeed honey-eaters; their tongues are armed on the point with papillæ as in the *Trichoglossinæ*." It is of great value to receive a positive statement as to the structure of the tongue in *Nestor*, the subject having hitherto been doubtful. Mr. Gould (Handb. B. Austral. ii. p. 551) declared that the tongue was not "furnished with a brush-like termination," whereas the correct figure of *N. norfolcensis*, given by Herr A. von Pelzeln (Sitzungsb. kk. Acad. Wissench. Wien, xli. 1860, p. 322, cum. tab. capit.), shows the papillæ very exactly. This new fact given by Dr. Haast sets all doubt at rest, and the position of the genus *Nestor* among the *Trichoglossinæ* now becomes evident.

GERYGONE ASSIMILIS, Buller, Essay, p. 9.

Mr. Buller separated this new species from *G. flaviventris*, more on account of the difference in the construction of their nests than from any shown by the birds themselves. I therefore expressed my doubts (Journ. f. Orn. 1867, p. 342) whether it was possible to distinguish the bird exactly. A specimen of *G. assimilis*, from Dr. Haast, convinced me at once that the skin of this species is not distinguishable from that of the true *G. flaviventris*. The specimen agrees in every respect with the description and figure given by Mr. Gray (Voy. 'Erebus' and 'Terror,' Birds, p. 5, pl. iv. fig. 1), except that the yellow tinge on the belly is paler; but the specimen is marked as a female.

TURNAGRA HECTORI, Buller, Ibis, 1869, p. 39.

The editor of 'The Ibis' has already suggested that this species is probably identical with *Otagon tanagra*, Schlegel (Nederl. Tijdschr. voor de Dierk. iii. 1865, p. 190). I agree with this supposition; for a careful comparison of the descriptions cannot admit of the slightest doubt as to their referring to the same species.

ANAS GRACILIS, Buller, Ibis, 1869, p. 41.

This is undoubtedly identical with *Anas (Querquedula) gibberifrons*, Salomon Müller (Verhandelingen, Land en volkenkunde, 1839–41, p. 159), as the comparison of a typical specimen of *A. gracilis* received from Dr. Haast with specimens from Timor in the Bremen Museum shows. The species has a wide geographical distribution. Timor (Sal. Müller, Wallace), Flores (Wallace), Celebes (Forster), Northern Australia (Leyden Mus.), South Australia (Leyden Mus., Haast), New Caledonia (Leyden Mus.).

* Translated by me in the 'Journal fur Ornithologie' for 1867, pp. 305—347.

Podiceps hectori, Buller, Essay, p. 19; Finsch, Journ. f. Orn. 1867, p. 345.

The distinctive character of this species, from our *P. cristatus* (Linn.), was declared by Mr. Buller to be the absence of white on the wings and shoulders. The collection contains a Grebe, which Dr. Haast mentions in his letter as a typical *P. hectori*. This specimen is partially moulting, as is especially shown by the fact that all the remiges are not fully grown, but are almost hidden by the tectrices. By unfolding the wings carefully, one can see the white distributed in the same style as in our *P. cristatus*, with which the specimen agrees in every respect. I therefore cannot regard *P. hectori* as distinct from our *P. cristatus* (*P. australis*, Gould).

Larus (Bruchigavia) melanorhyncha, Buller, Ibis, 1869, p. 43.

If this species is not identical with the badly described *Larus anderssoni*, Bruch (Journ. f. Orn. 1853, p. 102), from New Zealand, which Professor Blasius (*op. cit.* 1865, p. 384), declared to be nothing else than *L. scopulinus*, it certainly will be a good species. I, at least, cannot refer the fine specimen, received from Dr. Haast under the name last mentioned, to any of the known species, and take it for a good species, distinguishable by the slender black bill, tinged with a reddish tinge at the basal portion, and by the great extent of white on the remiges.

On some New Species of New-Zealand Birds. By Walter Buller, F.L.S., C.M.Z.S., &c.

[*From* 'The Ibis,' *for* January 1869.]

Fam. CERTHIIDÆ.

1. Xenicus haasti, sp. nov.

Upper surface pale olivaceous-brown, darkest on the crown; tinged on the back and on the outer margin of the quills with olivaceous-green; wing-coverts black, forming a conspicuous triangular spot; under parts pale fulvous; bill and feet dark brown; irides yellow.

Length 3·5 in.; wing from flexure 2; tail ·75; tarsus 1; middle toe and claw 1; hind toe and claw 1; bill, along the ridge ·375, along the edge of lower mandible ·625.

In structure this species approaches *X. longipes;* but the claw of the hind toe is more strongly developed, exceeding the toe in length. It is an inhabitant of the Alpine heights of the South Island; and I have named it in honour of its discoverer, Dr. Julius Haast, F.R.S., who forwarded me specimens for examination.

Dr. Hector found it frequenting the stunted vegetation growing among the loose mountain débris in the interior of the Otago Province: and Mr. Buchanan, the artist to the Geological Survey, met with it on the Black Peak, at an elevation of 8000 feet. There, where the vegetation is reduced to a height of only a few inches, it was constantly to be seen, fluttering over the loose rocks, or upon the ground, in its assiduous search for minute insects and their larvæ. Dr. Haast has favoured me with the following interesting notes on its habits:—"It lives exclusively amongst the large taluses of débris high on the mountain-sides. Instead of flying away when frightened, or when stones are thrown at it, or even when shot at, it hides itself among the angular débris of which these large taluses are composed. We tried several times in vain to catch one alive by surrounding it and removing these blocks. It reminded me strongly of the habits and movements of the lizards which live in the same regions and in similar localities."

Fam. LUSCINIIDÆ.

2. Sphenœacus rufescens, sp. nov

Upper parts, sides, and tail dark rufous-brown, brightest on the crown and hind neck; the feathers of the shoulders and sides centred with black. Quills dusky-black, margined with rufous-brown. Streak over the eye, throat, breast, and abdomen pale fawn-colour; sides of the head and ear-coverts marked with black. Bill light brown, with the ridge black; feet dark brown.

Length 7·25 in.; expanse 7; wing from flexure 2·5; tail 4·25; tarsus 1; middle toe and claw ·875; hind toe and claw ·75; bill, along the ridge ·5, along the edge of the lower mandible ·625.

This species is larger than *S. punctatus*, more strongly built, and of handsomer plumage. The specimen from which the description is taken was forwarded to me by Mr. Charles Traill, a gentleman greatly devoted to conchology. He obtained it on a small rocky isle, a satellite of Chatham Island, during an expedition there in pursuit of his favourite science, but was unable to give me any information respecting its habits or economy, though he stated that he obsered it flitting about among the grass and stunted vegetation, and succeeded in knocking it over with a stone.

Fam. TURDIDÆ.

3. TURNAGRA HECTORI,* sp. nov.

Upper surface olivaceous-brown; tail and coverts bright rufous, with an olivaceous tinge on the two middle rectrices; throat pure white; breast and abdomen ashy-grey, darkest on the former; abdomen and under tail-coverts tinged with yellow; sides olivaceous-brown, washed with yellow. Bill and feet dark brown; irides yellow.

Length 11 in.; wing from flexure 5·25; tail 5; tarsus 1·25; middle toe and claw 1·25; hind toe and claw 1; bill, along the ridge ·875, along the edge of lower mandible, 1.

I have honoured this fine species with the name of my esteemed friend Dr. James Hector, F.R.S., Director of Geological Surveys, who has done much to advance the cause of science in New Zealand.

It differs from *T. crassirostris*, not only in plumage, but in its superior size and more strongly-developed bill. Its notes also are far more varied and musical. Its range is confined to the North, while *T. crassirostris* is found only in the South Island. They are in fact the representatives of each other in the two islands, and furnish another example of a remarkable law in the local distribution of the birds of New Zealand, many of those inhabiting one island being represented by closely-allied forms in the other, each, however, being specifically distinct. Cook's Straits, a neck of sea only eighteen miles in width, completely divides the range of one set of species from that of the other.

Fam. PSITTACIDÆ.

4. PLATYCERCUS ALPINUS, sp. nov.

This Alpine form differs from its near ally, *Platycercus auriceps*, both in size and in the tints of its plumage. Our three species of *Platycercus* present a distinct gradation in size and colouring. In *P. pacificus* the frontal spot, ear-coverts, and thigh-spots are deep crimson, while the general plumage is dark green. In the smaller species, *P. auriceps*, the frontal band is crimson, and the vertex golden, while the general plumage is a warm yellowish-green. In *P. alpinus*, which is smaller again than the last-named species, the frontal band is orange, and the vertex pale yellow, while there is an absence of the yellow element in the plumage, which is of a cold pure green, much paler on the under parts. The thigh-spots moreover are much smaller than in *P. auriceps*, and are orpiment-orange instead of crimson. On comparing the bills of the two species the difference is very manifest, that of *P. alpinus* being fully one-third less than that of *P. auriceps*.

Length 8·5 in.; wing from flexure 4·25; tail 4·5; tarsus ·625; longest fore toe and claw ·875: bill, following curvature ·5, along edge of lower mandible ·25.

Dr. Haast, from whom I received several specimens of this bird, met with it in the forests of the Southern Alps, at an elevation of from 2000 to 2500 feet; and Mr. Travers sent me for examination other examples obtained by him in the high wooded country of the Nelson Province.

5. NESTOR OCCIDENTALIS, sp. nov.

Upper surface dark olivaceous-brown, tinged with yellow on the wing-coverts, each feather margined with dusky black; feathers of the nape dull red, margined with yellow and black, and forming a narrow nuchal collar; uropygium, tail-coverts, and abdomen dark arterial-red, the feathers of the latter banded with a brighter tint; ear-coverts pale orpiment-orange; feathers projecting over the lower mandible tinged with red; throat, neck, and breast dark olivaceous-brown; lining of wings and axillary plumes bright scarlet, obscurely barred with black, and tipped with golden-yellow; quills and tail-feathers russet-brown, the former toothed with yellow on their inner vane; bill and feet dark olivaceous-gray.

Length 16·5 in.; wing from flexure 10·5; tail 6; tarsus 1; longest fore toe 2·25; longest hind toe 2·125; bill, following curvature 2·25, along edge of lower mandible 1·5.

Apart from the difference of plumage, this species is appreciably smaller than the common one, while the bill is more slender and has the upper mandible produced to a finer point.

Dr. Hector discovered this bird in the densely wooded country on the west coast of the South Island, and he generously gave me the only two specimens which his collection contained. These differ very slightly in the details of their colouring, and there is scarcely any perceptible difference in their size.

Fam. SCOLOPACIDÆ.

6. GALLINAGO PUSILLA, sp. nov.

Upper surface dark rufous-brown, variegated with irregular spots of fulvous and black. These markings are most conspicuous on the back and scapulars, the feathers on

* [May not this species be identical with that described in 1865, by Professor Schlegel (Nederl. Tijdschr. voor de Dierk. iii. p. 190) under the name of OTAGON TANAGRA?—ED. "IBIS."]

these parts being margined outwardly with pale fulvous, and marked with a large subterminal spot of black. Under parts fulvous. Sides of the head and breast with numerous spots of rufous brown, of which there is also an irregular line from the base of the upper mandible to the anterior edge of the eyes; sides and flanks variegated with crescentic marks of rufous brown. Bill greyish brown; feet pale brown.

Length 8 inches; expanse 13; wing from flexure 4; tail 1·5; tarsus ·75; middle toe and claw 1·125; hind toe and claw ·3125; bill, along the ridge 1·75, along the edge of lower mandible 1·5.

The example from which the description is taken, was forwarded to me by Mr. Charles Traill, with the following note:—"Found on a small rocky islet off Chatham Island."

Fam. ANATIDÆ.

7. Anas gracilis, sp. nov.

Upper surface dusky-brown, with greenish reflections; the feathers of the back and scapulars narrowly margined with fulvous-white; the outer portion of the upper wing-coverts pure white, forming a conspicuous bar across the wing; the secondaries velvety black, narrowly tipped with fulvous, and a speculum of shining green occupying the outer vane of the three middle ones. Crown and nape blackish-brown, minutely marked with fulvous-white; throat, fore neck, and sides of the head fulvous-white, the latter marked with sagittate spots of brown. Under parts light fulvous-brown, with obscure spots of a darker shade, especially on the breast and sides, each feather having a broad central mark of blackish-brown. Throat and abdomen more or less tinged with bright ferruginous. Bill dark brown; outer portion of the lower mandible yellow. Feet pale brown.

Male.—Length 17 inches; expanse 25·5; wing from flexure 8; tail 4; tarsus 1·25; middle toe and claw 1·75; bill, along the ridge 1·5, along the edge of lower mandible 1·75.

Female.—Length 15·5 inches; expanse 23·5; wing from flexure 7·5; tail 3·5.

As will be apparent from the above measurements, the female is somewhat smaller than the male. The general tints of the plumage are paler; but in other respects the sexes are precisely alike.

The form of this Duck is remarkably slender and graceful, the contour of the body being almost as elongate as that of a Gannet. On dissection I found the skin very tender, and the flesh extremely delicate, with fat of a bright yellow colour.

I obtained my first specimens (male and female) in the Oroua Stream, near its junction with the Manawatu River, in the Province of Wellington. I observed that on being disturbed from the marsh, where they were apparently feeding, they rose high in the air, and came down suddenly into the creek with a rapid, oblique, and rather awkward flight. On the water they kept near to each other, and I killed both at one shot. I afterwards saw a pair on the wing, in one of the freshwater lagoons of the Upper Manawatu, the white bar being very conspicuous; and more recently I obtained a fresh specimen from Hawke's-Bay Province.* The species is evidently rare.

Fam. LARIDÆ.

8. Bruchigavia melanorhyncha, sp. nov.

Pure white; back and upper surface of wings delicate ash-grey. First four primaries white, variegated with black, the first primary narrowly margined on its outer and marked diagonally on its inner vane; on the next the black increases, and forms a broad subterminal bar, which is enlarged on the two next, and decreases on the two succeeding ones, all being tipped with white. The fifth quill, which is ashy, has merely a subterminal interrupted bar of black. Bill black; feet blackish-brown.

Length 14 inches; wing from flexure 11·5; tail 5; tarsus 1·5; middle toe and claw 1·75; bill, along the ridge 1·5, along the edge of lower mandible 1·75.

This bird may be readily distinguished from *B. scopulina* by its black bill and dark feet, those parts being blood-red in the other—and, on near inspection, by the different character of the markings on the primaries. All my specimens were obtained in the South Island.

Wanganui, New Zealand,
June 10, 1868.

* P.S. Oct. 3, 1868.—Referring to this species I have recently received the following interesting note from Dr. Haast:—"In a collection of Australian skins just arrived from South Australia, and collected by Mr. A. Fuller, there is a specimen of your Anas gracilis. I looked at once in 'Gould,' but could not find any mention of it; consequently this bird, so far as Australia also is concerned, is new to science. I compared the skins very carefully, and there is not the slightest difference; in fact it is almost impossible to say which is which. You can state this fact upon my authority."

Erratum.—Page 386, for "*Platycercus pacificus*" read "*P. Novæ Zelandiæ.*"

PART III.

PROCEEDINGS.

WELLINGTON PHILOSOPHICAL SOCIETY.

SESSION OF 1869.

PROCEEDINGS.

SECOND ANNUAL MEETING. *February* 9, 1869.

J. C. Crawford, F.G.S., Vice President, in the chair.

ABSTRACT OF REPORT OF THE COUNCIL FOR THE ANNUAL MEETING.

"There are now 117 members, from whom subscriptions to the amount of £133 7s. have been received. In accordance with a resolution of the council the subscriptions of eight members residing in other provinces have been returned to them at their request, or more strictly speaking, have been paid over to the treasurers of societies similar to this, in those provinces.

"The expenditure of the Society during the past year (and since its commencement under the name of the New Zealand Society, in November, 1867) has amounted to £84 18s. 2d., the details of which are shown in the accounts laid on the table.

"During the past year there have been six general meetings of the Society, of which an account will appear in the 'Proceedings of the New Zealand Institute,' now in course of publication. * * In future only those persons who join the Society before the 1st of October, will be entitled to receive a copy of the 'Proceedings' of the year, as subscriptions paid after the 1st of October are considered as being paid in advance for the following year, in accordance with rule 9.

"There have been seven meetings of the council during the year. Of these, and of the general meetings, minutes have been kept by the Secretary as required by the rules. These are at any time open to the inspection of members."

Report agreed to by the Council, January 29, 1869.

ROBERT PHARAZYN,
Hon. Sec.

In reply to questions, the Secretary stated that the balance in hand from last year amounted to the sum of £48 8s. 10d., and that only a few small accounts for advertising were outstanding, while, as would be seen from the accounts, all the larger items, with the exception of the contribution of one-sixth of the income of the Society to the Institute would not be annual charges.

ELECTION OF OFFICERS FOR 1869: *President*—Sir George Grey, K.C.B.; *Vice Presidents*—His Honor I. E. Featherston, M.D., Superintendent of Wellington, J. C. Crawford, F.G.S.; *Council*—W. T. L. Travers, F.L.S., J. Hector, M.D., F.R.S., W. B. Mantell, F.G.S., J. Kebbell, R. Pharazyn, F.R.G.S.; *Hon. Secretary*—R. Pharazyn.

Dr. Hector laid on the table the third annual report of the Colonial Museum and Laboratory, also a "Notice of an egg of the great Moa (*Dinornis gigantea*) containing remains of an embryo chick," communicated by himself to the Zoological Society of London.

Dr. Hector then gave an account of several recent additions made to the collection in the Museum, and called attention to the fact that the nests of New Zealand birds, of which a collection had been received from Mr. T. H. Potts, were very imperfectly known, that of the Huia not having yet been discovered.

Some interesting extracts were read by Dr. Hector from a letter of Captain Hutton's, describing the present state of the Thames Gold Fields.

Attention was also directed to a very fine collection of corals dredged by Captain Fairchild, of the steamer "Sturt," some of which appear to be of considerable importance

in a scientific point of view, from the fact of their being apparently identical with corals hitherto only found as fossils in the older Tertiary rocks.

Papers read :—(1.) "On the Sand-worn Stones of Evans' Bay," by W. T. L. Travers, F.L.S. (See ante, p. 247.)

In this the author gave an account of the mode in which certain curiously shaped stones, which appeared to be "flint implements," were formed by the cutting action of sand blown by the wind across a line of boulders between Evans' and Lyall's Bays.

(2.) Mr. J. C. Crawford read a short notice on the preservation of meat by bi-sulphite of lime, as proposed by Messrs Medlock and Bailey. The only objection to the process seems to be that the meat is too nasty to eat after being subject to the process described. A remedy may however be found for this, and the subject is of such importance as to be well worthy of careful investigation. He considered it desirable that we should carefully consider all plans and inventions which may be brought forward, having for their object the preservation of meat in these colonies, where it is superabundant, so that it may be transmitted in a marketable state to Great Britain, or other parts of the world, where the supply may be deficient.

As the bisulphite of lime is not an expensive article, the price named being 3s. 6d. per gallon, it will be easy for those who wish to try the experiment of preparing meat for shipment by this process, to do so without having to incur a large outlay.

(3.) An instrument for dusting vines and fruit trees affected with blight, with flour of sulphur, etc., was then described by Mr. Crawford. It is much used in France, and would no doubt be useful here, and any tinman can make it; but as Mr. Travers and Mr. Richmond remarked, the true remedy for blight and creeping things of all kinds is the judicious importation of birds, bearing constantly in mind the complex way in which the law of "natural selection" operates on every kind of animal life. As an illustration Mr. J. C. Richmond stated that the honey-eating birds had almost disappeared in some districts, owing to the bees having deprived them of their natural food.

(4.) A paper by Mr. Skey "On the Production of certain Crystalline Phosphates and Arseniates was read by Dr. Hector. (See ante, p. 146.)

Mr. Richmond exhibited some native curiosities taken from Ngatapa, given to him by the East Coast friendlies; some Raupo bread, prepared from the pollen of the swamp flag, *Typha angustifolia*, being amongst them.

Second Meeting. *June* 19, 1869.

J. C. Crawford, F.G.S., Vice President, in the chair.

The Secretary laid on the table eleven publications which have been presented to the Society since the previous meeting.

There were also several scientific works and periodicals placed on the table for the use of members of the Society, and eight volumes of the Catalogue of Fishes in the British Museum, presented to the Institute by the Trustees.

The election of the following new members was then announced by the Secretary :— Messrs. W. Best, J. Martin, N. Marchant, T. M. Stewart, H. Willcox, and the Rev. H. W. Ewald.

The Chairman, Mr. J. C. Crawford, then stated that as was the case last year, during the session of the Assembly the meetings of the Society would be at more frequent intervals, and that the next meeting would be held on the 17th of July. He then delivered the following

Address.

In opening the proceedings of the Wellington Philosophical Society for the session of 1869, it has fallen to my lot to make a few introductory remarks, and to glance at the events which have occurred since our meetings of last year.

I will first congratulate the members of the Society on the receipt of the first volume of "Transactions and Proceedings of the New Zealand Institute," which has lately been put into our hands. It appears to me in every respect a most creditable production for a colony of an age of less than thirty years, and although its bulk has been materially increased by the incorporation of Essays, which were originally written for the New Zealand Exhibition, yet the mass of matter contained in the ordinary "Transactions and Proceedings" is ample, and full of information of more than ordinary interest.

With regard to the Essays contained in this volume, I have been particularly struck with the care which has been bestowed upon those contributed by Mr. Colenso; and that, by him, on the "Maori Races," I consider particularly interesting.

As it appears to me that the usually received theory to account for the peopling of the Polynesian Islands (New Zealand inclusive) by the brown-coloured, Maori-speaking race, is quite untenable, I had commenced a paper on the subject, which I proposed to read at some meeting of this Society, but I find much that I had to say has been fore-

stalled by Colenso. I may perhaps still continue my paper, so as to bring on discussion and further consideration of the subject, for it appears to me one of very great interest.

Taken in its narrowest limits, the Polynesian race extends from New Zealand to the Sandwich Islands, occupying a larger area of the earth's surface than any other unmixed race on the face of the globe. Over the whole of this area the language spoken, although composed of many dialects, is obviously, even to a casual observer, *one* language. Moreover, the race has certain physical peculiarities particularly distinguishing it. The people are large-limbed, and muscular, well featured in general, and possessed of great natural intelligence.

To talk of this race as an Asiatic one, is to mislead entirely. The people are obstinate and determined to a degree, and differ from ordinary Asiatics both physically and mentally.

That a race, spread over such an enormous area, and speaking one language, should have peopled the Polynesian Islands by derivation from the crews of some wandering Malay vessels, seems to me an effect, produced by a cause so inadequate, that it cannot be supported.

Would it not also, *prima facie*, be more reasonable to trace the Malay from the Maori—the somewhat higher civilization from the lower—if, as I suppose, the Maori race to be a very ancient race, than the newer race from the older?

Excepting the extent of the globe over which the English language has spread by colonisation during the last century or two, and that over which Spanish is spoken—brought about by similar causes—the Maori tongue is used over by far a larger surface of the earth than any other language.

Although the effects of earthquakes are undoubtedly disagreeable, yet they are extremely interesting to science, and during the past year we have had considerable experience of them. It will hardly be necessary to remind you of the remarkable earthquake wave which visited our shores in August last, for a full description of the phenomenon appears in our "Transactions," from the pen of Dr. Hector; and no doubt he will, during the present session, give us full details of the earthquakes of October 18th of last year, which were so generally felt throughout the colony.

It seems probable that from the numerous points of observation in the Pacific which are now occupied by the restless and inquisitive colonists, whether of Great Britain or of the United States, the phenomena of earthquakes will be carefully watched, and possibly the laws which determine their recurrence may be arrived at. The earthquake which lately damaged Christchurch appears to have been extremely local. It conveys a hint to all towns in New Zealand, that buildings which may stand in London will not do for this colony. I have always expressed the opinion that, *prima facie*, one part of New Zealand was as likely to suffer from earthquakes as another, and, therefore, that the inhabitants should build their houses with reference to that risk, wherever they might happen to be situated. It may be as well again to suggest that a more durable material than timber is desirable for building your houses, even in earthquake countries, and I would call attention to my paper upon concrete.

During the past year the Thames Gold Fields have continued to be developed in a wonderful manner, and there is every reason to hope that when the country is open to "prospecting," the area of the gold field will be largely extended. I hear also, from good authority, that auriferous quartz has positively been found in the Kaimanawa range, part of which range lies within the boundaries of this province. Lately some pyritous stone from the Wainuiomata Valley has proved auriferous; and although the percentage of gold is small, it tempts to further search and investigation. Quartz, showing a few specks of gold, has also been brought into town from Makara.

It has also been reported that gold has been found in that part of the Ruahine range which lies near the Rangitikei river, but as reports of this character have been so frequent and so fallacious, it may be as well to suspend our judgment until we see the specimens. I am glad to find that the search is now for veins instead of for alluvial "diggings." I was convinced years ago that the "alluvium" in this vicinity has been pretty well tried and found barren, or too poor to pay, and that the prospects of finding gold, if it was to be found, lay in the development of auriferous veins.

The discovery of large quantities of Saurian bones at the Waipara river, in the Province of Canterbury, is an event of great importance, in a scientific point of view. I have to congratulate my old friend Mr. Hood, both on the original discovery of these fossils some years ago, and on his now having secured, at considerable trouble to himself, a number of valuable specimens which he has transmitted to England for examination by Professor Owen.

Other specimens have lately been procured by Mr. R. L. Holmes, who was specially sent for that purpose, and which may now be seen in this Museum.

I think it will be desirable for me to confine my remarks to subjects of colonial interest, although there are matters of science and discovery, which have cropped up during the year, and which might be noticed with advantage were it not that it would

swell the dimensions of the address too much. I would particularly refer to one subject, the measurement of an arc at the Cape of Good Hope, the result of which measurement is to show that the Southern Hemisphere bulges as it were, or "has the mumps" as I have heard it graphically expressed. Thus the comparative low barometer in the Southern to that in the Northern Hemisphere is accounted for. The boundary of the atmospherical envelope being supposed to be in regular spheroidal gradation from the centre of the earth, if the surface of the globe is irregular that part which is furthest from the centre will of course have the least atmospheric pressure. I will mention, as a tribute to the sagacity of Dr. Hector, that some five years ago, in Dunedin, he explained to me the reason of the low barometer in the Southern Hemisphere, and his theory, then expressed, has now been proved correct by observation.

In conclusion, I would particularly impress on the members of this Society, the necessity for striving to keep up its scientific tone, and for this purpose to provide as many good papers as possible to be read at the meetings. I would particularly call their attention to the "Transactions" of the Auckland Institute. Let us enter into a noble rivalry with them, or with any others of the affiliated societies. One advantage in a warfare of this kind is that no one is the loser. Supposing that we are beaten we have the advantage of the information supplied by our antagonist, if we can apply such a term to a member of the affiliated society. Let us then do our best.

Papers read:—

(1.) "On the Anatomy of the Swordfish of the Southern Seas," by F. J. Knox, L.R.C.S.E. (See ante, p. 13). The author stated that European naturalists were very imperfectly informed about this species; he made frequent reference to a specimen on the table which has been presented by him to the Museum, and the points to which he drew especial attention were the following:—

The existence of well-marked incurved teeth of small size, covering the interior surface of the jaws, and the sword-like prolongation.

This circumstance is particularly noted, as characteristic of the genus Histiophorous, by Gunther, but has not been recognised as a structure essential to the method by which the swordfish captures its food.

Dr. Hector stated that he understood from Dr. Knox that the whaler's account of the conflicts between the whale and the swordfish were only due to their rivalry for the purpose of obtaining the same food, which he believed to be the cuttle-fish or squid. He pointed out the great development of the eye and optic nerve, far in excess of all other similar sensory apparatus, also the contrivance by which the dorsal fin has both a lateral and longitudinal motion, no doubt for the purpose of enabling it to direct its aim with certainty when using its sword for impaling its prey.

(2.) "Preliminary notice on the Effects of the Application of the Hot Blast to Blowpipe purposes," by W. Skey. (See ante, p. 148.) The result of the author's experiments has shown that, by a very simple and inexpensive contrivance, platinum and other infusible substances can be melted, and the Bude light produced, and that the process could not fail to replace the dangerous and expensive oxy-hydrogen flame.

The author promised, if possible, to demonstrate the process by experiments at the next meeting of the Society.

(3.) "Remarks on the Coast Line between Kai Iwi and Waitotara, on the West Coast of the Province of Wellington," by R. Pharazyn (the Hon. Sec.) (See ante, p. 158.) Several diagrams and sections explaining the author's views with regard to the origin of the great sandhill formation which surmount high cliffs overhanging the coast, were laid on the table.

Dr. Hector, in the absence of Dr. Grace, exhibited a sample of the extract of beef prepared by Mr. Roberts, of Wanganui, on a new principle, by which many of the objections to the well-known Tooth's extract are considered to be avoided. The essential feature in the process is the extraction of the juice of the raw meat by direct pressure, after which it is evaporated to an extract. The sample appeared to be generally approved of.

THIRD MEETING, *July* 17, 1869.

J. C. Crawford, F.G.S., Vice President, in the chair.

The election of the following new members was announced, viz.:—Messrs. T. Buchanan, E. Gillon, and W. Luxford.

The Honorary Secretary read a list of valuable scientific works, which have been presented to the Society by Mr. W. Lyon, F.G.S., to whom a vote of thanks was passed for his valuable donation. A communication was read from the Hon. the Colonial Secretary relative to the scholarships which were formed last year by Mr. Whitworth, whose name is so familiar in connection with the modern improvement in the manufacture of

fire-arms. These scholarships, thirty in number, of the annual value of £100 each, are for the purpose of assisting the study of the theory and practice of mechanics. The scholarships are now open to competition to all British subjects, and it appears that application has been made to ascertain whether colonial youths who compete may be examined by a Board locally appointed. The reply is in the negative, but with an assurance that the importance of making some such provision for the future will not be lost sight of.

Dr. Hector directed attention to the skeleton of the elephant in the Museum, for which munificent donation the Institution is indebted to the Hon. John M'Lean, M.L.C., who secured the carcase and had the bones cleaned at very considerable expense, and with such care that the articulation of the skeleton was easily effected on its arrival at the Museum without further preparation.

He also read the following extract from the February number of the "Student," which gives an account of how this elephant met its death, on the authority of Dr. Haast :—

"The most remarkable instance of the poisonous properties of the Coriaria is mentioned in a letter from Dr. Haast, of Canterbury, New Zealand. It occurred to an elephant which, after being landed in Otago, was marched inland by its owner for a considerable distance. Arriving at a suitable halting place, where the vegetation was abundant, the owner determined to give the animal a spell of a few days' feeding. The grass, which had been burnt off during the previous season, had shot up again with renewed vigour, and amongst it was a very fine crop of succulent young plants of Coriaria. The elephant fed amongst this herbage for four hours, and afterwards went to a neighbouring creek and had a long drink. In turning back, the animal began to reel, fell on the ground, and died after three hours ; so that it took only seven hours from the time the beast began to feed amongst the plants, until he died. It would seem from this instance that the poison must be very virulent. It is, moreover, remarkable that the elephant should, like sheep and cattle, eat the plant, while the horse will not touch it."

A Report on, and Maps of the Gympie Gold Field in Queensland, by T. R. Hacket, a member of the Society, communicated for the information of members by Dr. Hector, who drew attention to the striking similarity of the geology of the Gympie gold fields to the Thames district.

Mr. Skey informed the meeting that owing to the incompletion of the gas fittings he was unable to fulfil his promise of demonstrating the action of his hot blast blow-pipe.

Papers read :—

(1.) "On the Habits and Nidification of some of the Birds of New Zealand," by T. H. Potts. (See ante, p. 40.) Only extracts from this communication could be read. In the introductory portion the author discusses the necessity for the practical study of natural history in a country where there is no game, as it afforded that great necessity for bodily and mental health—outdoor pastime. The observations made by himself and sons during a long residence in the Province of Canterbury, where he acquired favourable opportunities for pursuing this study, were embodied in the paper in the hope that others might be attracted to devote some of their time to the same pursuit. The author then described the different forms of nests which occur in New Zealand, and drew inferences as to the objects of the various modifications. Referring to the habits of the birds, he discussed the many causes that have led almost to the extinction of so many species ; and gave a graphic description of a locality which not many years ago was a favourite breeding ground for upwards of thirty species, but where now hardly any are to be met with. The remainder of the paper gives a detailed description of the habits, nidification, and eggs of forty-two specimens of New Zealand birds, from original observations.

Dr. Hector mentioned that most of the eggs and nests referred to in the paper had been presented to the Museum by Mr. Potts.

(2.) "On the Alkalinity of Carbonate of Lime," by W. Skey. (See ante, p. 150.) This paper showed by experiment that contrary to the usual opinion the above substance is always alkaline in its reaction, whether prepared chemically, pure, or existing in natural crystals.

(3.) "On the Absorptive Properties of Silica and its direct Hydration by contact with Water," by W. Skey. (See ante, p. 151.) This gave the results of experiments in continuation of those mentioned in No. 157 of the "London Chemical News." The practical bearing of the paper was to prove that the so-called mechanical absorption of soils was a purely chemical reaction.

(4.) "On the Results of the Examination of the Bark of *Coprosma grandifolia* for Alkaloids," by W. Skey. (See ante, p. 152.) A careful examination has failed as yet to trace the powerful bitter of this substance to the presence of an Alkaloid.

(5.) "On Silver Ore from Stewart's Island," by W. Skey. Being the result of the analysis of a specimen of quartz gangue containing six ounces of silver to the ton, associated with iron pyrites,—no gold was found. The vein is from the junction of fine grained

granite with blue slate, and has been discovered by a prospecting party fitted out by Mr Daniels, of Riverton.

(6.) "On the Anatomy of the Tuatara (*Hatteria punctata*)," by F. J. Knox, L.R.C.S.E. (See ante, p. 16.) This paper gives, as the result of the dissection and preparation of two specimens which were exhibited, the points in the anatomy of this interesting lizard, where the author had found it necessary to differ from the memoir by Dr. Günther on the same subject. Both the specimens examined by the author were, however, females, while the single specimen dissected by Dr. Günther was a male. Some of the differences the author was almost inclined to regard as characteristic of a different species.

(7.) "Comparative Review of the mode in which Gold occurs in the North and South Islands of New Zealand," by Dr. Hector. The author rapidly reviewed the evidence of the nature of the matrix of the gold in Otago, Westland, and Nelson, and showed that in the North Island the essential conditions for the presence of gold are found in lines of dislocation, which by creating vertical bands of metamorphic rock, render auriferous, formations that never yield gold in the unaltered state. In the case of the Thames gold fields this vertical metamorphism had been accompanied by the eruption of igneous rocks of mesozoic age, and the metallic deposits have been still further concentrated by the eruption of tertiary volcanic rocks and thermal waters in the same district. Around Wellington there were no igneous rocks, and the gold that has as yet been found in the neighbourhood was derived from bands of slaty rock, in lines of dislocation that run in a north and south direction. With the assistance of coloured sections he explained the geological structure of the country around Wellington, and compared it with the Thames district, showing the absence of the most characteristic rocks which are associated with the gold there. He warned miners from expecting too much from the hard compact quartz reefs that traverse the indurated sandstone in the neighbourhood of Wellington, as most at least of them were of higher antiquity than the dislocations by which the gold has escaped from the deep seated rocks.

In answer to Mr. Marchant, the author stated that at Taranaki similar volcanic rocks occur as at the Thames, but no slate rocks had yet been found associated with them, which, he believed was one essential required to complete the similarity of conditions ; at the same time he had seen very likely-looking specimens from the Kaitaki ranges, but they had not yielded gold on analysis.

The most marked junction of the trachytic rocks with the slates he had met with was on the west side of the Kaimanawa Range, south of Taupo Lake, and to which he had referred in a recent report.

(8.) "On the Alluvial Gold in the Province of Wellington," by J. C. Crawford, F.G.S. (See ante, p. 160.) The author described the probable distribution of alluvial gold, if any quantity exists in this province, and directed attention to the higher levels in the old terraces which skirt the ranges on the west, and also are found in patches in the wider valleys.

FOURTH MEETING. *August* 14, 1869.

J. C. Crawford, F.G.S., Vice President, in the chair.

The election of the following new members was announced :—Sir David Monro, Mr. F. A. Krull, and Dr. Knight.

Dr. Hector gave an account of some interesting results obtained in the Laboratory during the past month. He stated that the Urinui clay, which is being used in the reduction of the iron sand at Taranaki, had been found to possess no special properties either as a means of binding the sand mechanically, or as a flux, in both of which respects it is inferior to many other clays, as it only contains 30 per cent of clay, mixed with 65 per cent. of sand, and only 3 per cent. of lime. The specimens analysed had been forwarded by Mr. T. Kelly, the Provincial Secretary. A concretionary mass from the same clay had been found to contain 30 per cent. of lime.

A vesicular rock which had been brought to the Museum by some diggers from Makara as a volcanic tufa or scoria, had proved to be a porous form of silica that had a very similar composition to the scinter deposited by the hot springs. It however in no respect resembles the auriferous tufa from the Thames District.

Papers read :—

(1.) "On the Extraction of the Poisonous Principles of the Tutu Plant (*Coriaria ruscifolia*)," by W. Skey. (See ante, p. 153.) By a process which he described he has discovered the poison to be a greenish oil, five minims of which administered to a cat produced, in the course of half an hour, a succession of violent convulsions, following at intervals of twenty minutes, accompanied by twitchings and contraction of the extremities, and dilation of the pupils. A large proportion of the dose was vomited within a few

minutes after it was administered, so that the poison must be extremely powerful. The quantity of the poison contained in the seed is 12 per cent. of the weight. Sir David Monro stated that he had seen the cat while under the influence of the poison, and that the symptoms exactly resembled those of a sheep that had eaten the Tutu plant, except that the hind legs of the cat seemed to be paralysed, while a *Tuted* sheep stood erect and had free use of its extremities, although unable to direct its movements. Specimens of the poisonous oil in different stages of its production were exhibited, and also the oil of the Karaka seed.

(2.) "On two Seals of the genus Stenorhyncus, captured on the East Coast of Otago," by J. S. Webb. (See ante, p. 28.) This paper described two specimens of seals which are in the Otago Museum. The author considered these to be a new species belonging to the genus *Stenorhyncus* which he proposed to name *S. Crassicollus*, his principal argument being that it is not *Stenorhyncus Weddellii*. The paper was illustrated by photographs of both specimens.

Dr. Hector said that Mr. Webb had been misinformed as to this seal having been seen by him on the West Coast of Otago; the only one he had ever seen was at Moeraki, forty miles north of Dunedin. He pointed out that having had access to works which Mr. Webb had not been able to refer to, he had been able to determine the specimens described to be the young male and female of *Stenorhyncus leptonyx*, a species originally confounded with *Leptonyx Weddellii*. Mr. Webb is thus right in distinguishing it from that seal, which has not yet been found in New Zealand. Dr. Gray first distinguished these seals from specimens of two skins and skeletons, accompanied by a minute anatomical description of one captured in Wellington Harbour, and sent to the British Museum by Dr. Knox many years ago. Mr. Webb's description, measurements, and photographs all compared with that specimen. Dr. Hector exhibited a skull of one of the seals in question, prepared by Dr. Knox, and also the coloured drawings of specimens of both species of the seals referred to.

(3.) "On the Anatomy of *Naultinus punctatus*," by F. J. Knox, L.R.C.S.E. (See ante, p. 20.) This paper gave a minute description of the anatomy of the green lizard, in the course of which the author discussed the theory that the lizards have the power of reproducing the tails when they are broken off. He showed that the tail broke at a definite place marked both in the skeleton and on the cuticle, and expressed an opinion that no reproduction could take place.

Mr. Buller remarked that Dr. Knox was mistaken in the species, and that the lizard he had described was *Naultinus Greyii* and not *Naultinus punctatus*. He further pointed out that in the Museum there were two specimens of lizards, in one of which the tail was forked, and in another, a small appendage had evidently been reproduced from a broken stump. Dr. Knox not being present, no explanation was afforded to account for these specimens.

(4.) "Description of a new species of *Ophisurus*, found on the Coast of New Zealand," by Dr. Hector, with "Anatomical Observations," by F. J. Knox, L.R.C.S.E. (See ante, p. 34.) This paper described a species of serpent eel found in a tidal creek near Poverty Bay, and forwarded to the Museum by Mr. Campbell, R.M.

Mr. Buller said he had never heard of this curious fish among the natives, and thought it must be very rare.

Sir David Monro suggested that the specimen should be dissected, in order to determine the structure of the breathing apparatus, as there might be in this genus, the anatomy of which was imperfectly shown, an intermediate form of respiratory apparatus between the reptile and the fish, as had already been detected in the Protius, Axylotyl, and Syren.

(5.) "On the Physical Features of the River Basins of the Wellington Province," by J. T. Stewart. (See ante, p. 198.) This paper contained a minute description, and gave comprehensive details of the topography of the southern and eastern districts of the province, classifying the different water-sheds of the principal rivers and streams, and the relative drainage area of each, with comments on the valleys affected by floods from various quarters, and suggestions as to the districts in which it will be necessary to conserve the forest, in order to prevent alternations of droughts and floods in some of the valuable districts of the province.

Mr. Crawford and Dr. Hector made comments on this paper, especially with regard to the distribution of the alluvial terraces, and the relative levels to which river terraces extend, which seem to be about 800 feet above the level of the sea, all over the province.

(6.) "On Irrigation, as applied to the Culture of New Zealand Flax," by J. C. Crawford, F.G.S. (See ante, p. 129.) The author pointed out the importance of irrigation to produce abundant crops of the flax plant, and described the different methods of applying it, and the districts in this province where they could be employed in a remunerative manner. He indicated the sandy tracts on the West Coast as being most available.

Fifth Meeting. *September* 18, 1869.

J. C. Crawford, F.G.S., Vice President, in the chair.

In accordance with clause 7 of the New Zealand Institute Act, it was necessary for the Society to appoint one of its members to vote in the election of Governors of the New Zealand Institute for the ensuing year, and Mr. J. C. Crawford was unanimously selected for this office.

Papers read :—

(1.) "On Thorough Drainage," by Mr. Crawford. (See ante, p. 211.)

Mr. Travers quite agreed with the suggestions made by Mr. Crawford, but thought there would be some difficulty in carrying out the system of thorough drainage in New Zealand, as he was afraid the proprietors of land would not work harmoniously in the matter. There should be an Act passed on the subject.

Mr. Hamilton thought there would be a difficulty in draining the clay hills effectually, so as to produce percolation, as the superficial layer of soil is the most tenacious, and the water runs off the surface.

(2.) "On the Mysticetus, or Right Whale," by F. J. Knox, L.R.C.S.E. (See ante, p. 21.) A specimen of the head of *Balæna marginata*, Gray, was exhibited at the meeting, to illustrate this paper. The author gave a most interesting account of the habits of whales in general, and pointed out particularly the difference between the Mysticetus and the Rorquals, a drawing of which latter he exhibited. The use of the baleen was graphically described, especially as there were some fine specimens with the head above mentioned.

(3.) "On the Upper Tertiary Fossils of New Zealand, with Lists of the Species," by J. Buchanan. (See ante, p. 163.)

(4.) "On the Tertiary Series of Oamaru and Moeraki, Otago," by C. Traill, communicated by Dr. Hector. (See ante, p. 166.)

Sixth Meeting. *November* 13, 1869.

W. T. L. Travers, F.L.S., in the chair.

The Honorary Secretary, Mr. R. Pharazyn, intimated resolutions received from the Governors of the Institute to the effect that papers intended for the "Transactions," will in future require to be forwarded in the form in which they are read before the Society, and that authors will be entitled to receive twelve copies of their papers in a separate form.

Dr. Hector called attention to two live specimens of the mud fish from Hokitika, *Neochanna apoda* of Günther. The specimens were swimming actively in clear water, and had perfect vision, although their eyes are small, so that the undeveloped state of the eye in the specimen previously received, and described by Dr. Günther, must have been exceptional.

The Hon. W. Fox remarked that these mud fish were not peculiar to Hokitika, as five years ago he remembered seeing a fish dug up from a gravelly clay ten feet below the surface, at Rangitikei, and he believed that it was identical with the fish exhibited.

A remarkable meteor observed in Wellington on the 8th inst., at 11.30 p.m., was described in a paper by the Rev. A. Stock. It appeared suddenly in E.S.E., at an altitude of about 20°. It fell with a very rapid motion, vertically. When it was first seen it appeared about three times as large as Venus, and shone with a yellow light. It suddenly appeared to diminish to a point of light, each diminution being accompanied with a shower of sparks falling vertically. It as suddenly increased to its old brilliancy, as suddenly diminished, then increased. Thus there were three brightnesses, and two darker intervals. Another peculiarity was that it showed all the prismatic colours. There was no train of light left after its disappearance.

Mr. J. Kebbell and Mr. Gillon corroborated Mr. Stock's observations.

Papers read :—

(1.) "On some New Species of New Zealand Plants," by J. Buchanan. Specimens were laid on the table. (See ante, p. 88.)

(2.) Dr. Hector gave a short abstract of an elaborate report by Mr. T. Kirk, of Auckland, "On the Botany of Cape Colville Peninsula." (See ante, p. 89.) This paper gave the results of a survey that had been made for the Geological Department, with the view of obtaining an accurate record of the original vegetation, as the flora of the district is undergoing rapid modification by the gold diggers. In this paper several new species of plants were described, of which specimens were exhibited.

(3.) "Description of the Mechanical Apparatus employed in raising the s.s. Taranaki," by J. T. Stewart. (See ante, p. 203.)

Mr. W. Allen criticised the paper, and regretted that it did not give information on many interesting points that had been observed in the course of this important undertaking, with which he had been connected from the commencement.

He understood that Mr. Stewart had not been a personal observer of the operations, and therefore had relied on information supplied by others. He attributed the success very greatly to the cage described by Mr. Stewart, which had been contrived to afford a working stage to contain the divers and their tools. One of the great difficulties the company had to contend with was want of information on the subject; for instance, they could not find out whether divers could conduct operations at so great a depth. The first attempt, it might be remembered, had cost the life of a diver, but this he believed was due to the physical weakness of the man. Subsequently the divers had experienced no ill-effects from remaining as long even as 110 minutes at the more moderate depths, but when at the greatest depth, 100 feet, they rarely stayed down longer than fifteen minutes. He trusted that no facts that had been noted respecting this interesting, but he feared not remunerative undertaking, would fail to be recorded.

Dr. Hector directed attention to a collection of the marine animals that were found on the vessel, among which are three species of *Anomia*, two of *Mytilus*, *Ostrea*, *Pecten*, *Serpula*, *Balanus*, and *Teredo*. He remarked that some of these animals are usually found only slightly below low-water mark; and their occurring so well-grown within a year at the depth of 100 feet, seemed to indicate that depth of water did not so much control their existence, as a supply of nourishment, and that this was probably abundant near the wreck.

Some discussion, in which the Chairman, Mr. Mantell, and Mr. Marchant joined, ensued as to the evidence afforded by the wreck that marine animals require access of light for their development, but the observations made did not appear to settle the point.

(4.) "On the Effects of the Application of the Hot Blast to Blow-pipe Purposes, etc.," by W. Skey. (See ante, p. 148.) Mr. Skey showed that the temperature obtained by the common blow-pipe, with proper precautions against conduction of heat, was at least 5100° Fahrenheit, as it is capable of fusing fine points of platinum.

(5.) "On the application of Iodine and Bromine for the detection of Gold when in minute quantities," by W. Skey. (See ante, p. 156.) The author described a new process which had been recently adopted in the laboratory, to facilitate the analysis of supposed auriferous quartz; when sulphides were present in large quantities, iodine or bromine is used as the solvent, and a rapid test is obtained by dipping filter paper in the solution, and burning it with due care, when if gold be present a very characteristic purple hue is imparted to the ash. By this test the presence of gold, in the proportion of one dwt. in the ton, can be detected with great economy and certainty.

(6.) "Preliminary Notes on the Bones of a Fossil Penguin," recently discovered on the West Coast of Nelson, and presented to the Museum by Mr. Dingan, by Dr. Hector. The discovery is interesting, as a fossil bone discovered by Mr. Mantell in the Oamaru limestone of Otago, in 1849, was pronounced by Professor Huxley to belong to a gigantic penguin five feet in height. The fossil bones found by Mr. Dingan appeared to be those of a bird about four feet high, and therefore not larger than penguins that still exist in the antarctic regions. The fossil shells, sent from the same formation as the bones, indicate that they belong to the lower pliocene period.

(7.) "On the General Principles of an Education Scheme for New Zealand," by W. S. Hamilton. (See ante, p. 196.) The chief object of this paper was to show that sound education of youth is of vital importance to the success of the colony—that it can only be obtained by a careful selection of teachers through a system of licensing, and by general examinations of the scholars' certificates being granted, that would be generally accepted as a criterion of proficiency, and afford a standard for the schools to work up to. Mr. Hamilton, in the course of his paper, criticised the relations of the Government in the existing schools.

Mr. Mantell, in discussing his remarks on this subject, did not see that any Government could improve or originate any system unless the movement was in accordance with the general wish of the people. He pointed out that where the inhabitants appreciated the benefits of education, as in Otago, there a good system existed.

Mr. Pharazyn thought that nothing would be done towards improving the present state of things unless the educated members of the community led the way, he therefore agreed with the object of Mr. Hamilton's suggestions.

The Chairman then stated that two papers remained on the list, but it was so late that they could only be briefly noticed.

(8.) One was a most elaborate series of "Tables for facilitating the use of the Aneroid Barometer in Mountainous Countries, with explanations," by E. Dobson, C.E. (See ante, p. 223.) This paper was intended to supply a practical want which had been felt by Mr. Dobson when making engineering surveys in New Zealand mountains, and no one could be more qualified than he to produce a valuable and accurate work of the kind.

(9.) The other paper was an account by Dr. Hector of "The Geology of the Outlying Islands of the New Zealand group." (See ante, p. 176.) From various reports, accompanied by specimens of the rocks obtained from the islands during the last few years.

Several additions to the Museum were exhibited, including a beautifully prepared skeleton of a dolphin, and specimens from the supposed auriferous reefs in Canterbury, Wellington, and Kaimanawa ranges.

A series of photographs by Mr. Igglesden, showing the progress of the works on the Cape Campbell lighthouse, were also exhibited from the Marine department.

AUCKLAND INSTITUTE.

SESSION OF 1869.

PROCEEDINGS.

ANNUAL MEETING. *February* 15, 1869.

Captain Hutton, F.G.S., in the chair.

The Secretary, Mr. T. Kirk, read the report of the last year and the balance sheet.

ABSTRACT OF REPORT.

The Auckland Institute was formed at a meeting held November 6th, 1867, and, in pursuance of a unanimous resolution passed at the first monthly meeting, was formally incorporated with the New Zealand Institute on June 10th, 1868.

During the past year monthly meetings of the members were held in the Museum, at which fifteen papers were read, which are now in course of publication in the "Proceedings of the New Zealand Institute." (See Vol. i., p. 135, *et. seq.*)

Field excursions of the members have been made to the Tufa craters of Waitomokia, the North Head of the Manukau, and to the caves at the Three Kings, during which much interesting information was collected respecting the geology and natural history of the districts visited.

Sixty-nine donations have been received by the Council for the Library and Museum of the Institute.

The increasing interest evinced in the objects of the Institute impels the Council to point out that largely increased funds are necessary before they can be carried out to any extent, to express its earnest hope that the members will use their influence to induce new members to join, and as far as possible to give active assistance to the Institute in its endeavours to diffuse a knowledge of the resources of the colony.

Fourteen scientific periodicals are in circulation amongst the members of the Institute.

THE TREASURER IN ACCOUNT WITH THE AUCKLAND INSTITUTE.

Dr.	£	s.	d.
To subscriptions	68	5	0
,, Balance from excursion fund	0	10	4
	£68	15	4

Cr.	£	s.	d.
By Periodicals	11	5	4
,, Black board	7	0	0
,, Curator	25	0	0
,, Advertisements and printing	10	16	8
,, Lamps	4	14	0
,, Stationery, postage, &c.	3	2	9
,, Balance	6	16	7
	£68	15	4

February 15, 1869.

Election of Office Bearers for 1869: *President*—T. B. Gillies; *Council*—Rev. J. Kinder, T. Kirk, Dr. Stratford, F. Whitaker, F. W. Hutton, F.G.S., Dr. Purchas, T. Peacock.

Mr. Owen was requested to audit the accounts of last year.

Second Meeting. *June* 7,

T. B. Gillies, President, in the chair.

A list of thirty-seven donations to the Library and Museum of the Institute, received between 15th February and 5th June, was read by the Secretary.

The President delivered the following

ADDRESS.

It is a remarkable fact in the statistics of mortality, that the large proportion of deaths occur during infancy, childhood, and youth. Every year that the child survives, greatly increases its chance of attaining to maturity. Infancy is the season of the greatest risks. With a physical frame undeveloped, vital energies weak, and wholly dependent on external aid for nourishment and protection, the chances are many against the prolonged life of the infant. On its constitution, its internal vitality, it has mostly to depend, so as to survive the carelessness of nurses, the foolish fondness of mothers, and the dangerous attention of doctors. But even when infancy is over, the risks are only reduced, not surmounted. Years must pass ere the physical and mental powers are developed and consolidated—ere the man becomes a contributor to the progress of humanity.

As with the individual, so with schemes and societies. Infancy to vast numbers of them is fatal—childhood scarcely less so. On this, the opening of the second year of the existence of this Society, I have to congratulate you on having successfully survived the infantile stage,—not from having a robust physical frame, for our numbers are but small compared to what they ought to be in so large a community, and the number of our active working members smaller still. Our comparative success has, I think, been owing much to the internal vitality, the intense interest evinced by many whom I see around me, and to the same cause I confidently look forward for a prolonged existence for our Society. Our constitution, too, the excellence of the objects for which we are associated, give me hopes for the future. As in all nature, atoms have a tendency to find their affinities and combine with them, so I believe that the very existence of this Society, having for its object the promotion of scientific knowledge, will draw towards it many an unknown and humble worshipper at the shrine of science, whereby the Society will be strengthened, and its usefulness increased. That such may be the case is, I am sure, your earnest desire, as it is mine.

And here, gentlemen, permit me, not for your sakes, but for the sake of some to whom perchance these words of mine may reach, to endeavour to state clearly the position which we, as a Society, assume, and to remove, if possible, some erroneous impressions which have gone abroad and been propagated in regard to us. We assume to be a scientific society, but this description seems to be greatly misunderstood. We do not assume that each individual member of this Society should profess to be versed in science, should be a man of scientific acquirements. All that is required or desired of members of this Society is, that they should recognise the benefits which scientific knowledge confers on the world, and may confer on this community; that they should have a love for science and a desire to see it progress, and that they should be willing to contribute, however humbly they are able, to the advancement of scientific knowledge. This is all that I and many others of this Society can pretend to, and although I see before me some who may fairly aspire to the title of scientific men, yet these I know are the very men, who, with the true humility of science, undervalue their own attainments, who feel that what they do know has only taught them how little they know, and has whetted their appetite for an increase of knowledge. I fear, however, that the very terms science and scientific knowledge convey to many nothing beyond a vague idea of something very learned, something very abstruse, which it is hopeless for ordinary men to attempt to have anything to do with. It is true that science in its more exalted sense means a knowledge of the general laws which explain, and are deduced from, large bodies of isolated physical facts. But it must ever be borne in mind that the facts must be determined first ere the laws explanatory of or governing these facts can be deduced. The same man cannot (except in very rare cases) both ascertain for himself the facts, and generalise upon them, so as to elucidate the laws governing their existence.

There must be in the field of science, as in all other branches of industry, workers as well as masters—collectors of facts as well as generalisers upon the facts ascertained—and the workers must come first, the facts first, the theories built upon them afterwards, other-

wise the theories are but of slight value. In other words (to follow the Duke of Argyle's formula in his definition of law) we must determine the "what" first, ere we can aspire to know the "how" or the "why." We, in this Society, can scarcely, perhaps, profess to be more than mere fact-collectors—sometimes hazarding a theory or a speculation, grasping, as the human mind ever tends to do, at the "how" and the "why;" but endeavouring always to collect and verify facts of the physical world, which facts may perhaps prove of value in the hands of some other member of this Society, or of some other person of more extended scientific knowledge. And let no one depreciate the mere fact-collector. One well authenticated fact, though it cannot alone sustain, may overthrow a brilliant—it may be, even an accepted—theory. We ask, then, all to join us who are willing to observe and record facts coming under their observation, accurate observation being at the foundation of all scientific knowledge. And here, I may remark, that it seems to me too little attention is paid to the cultivation of the faculty of observation amongst our children. Were we to attend more to the cultivation of this faculty, we should find that what is an effort to us, would soon become a habit with them, and great results, would, I venture to say, flow from such a course, especially in a community like our own, where rapid change seems to be an essential element of existence—where the workman of to-day is the capitalist of to-morrow—where new faces are constantly usurping the place of the old around us—where a very few years consign to privacy or oblivion our public men, and supply their places, not by a succeeding generation, but by a new race. I say, in such a community, it especially becomes us to cultivate the habit of observation of facts as they pass before us, and to cultivate, moreover, the habit of recording these facts for the assistance and guidance of our successors, who may never have the opportunity of observing what we have observed.

Need I ask you to look at how little has been done during the nearly thirty years' existence of our colony in the way of determining such patent facts as the geography, the botany, the zoology, the geology of our country—not that we need expect a few years—no, not even a few lifetimes—to exhaust the stores which even in these respects are open to our view. But had any number of our colonists during these thirty years devoted themselves to observing and registering facts which have come under their observation, had we each one in his own little circle done so, how great would now the mass of ascertained facts be available to the world, to our fellow-colonists, and to those whose habits and powers of mind could have reduced those facts into order, grouped them under their appropriate laws of how they came thus to exist, or even aspired to the higher flight of mind in pointing out why they have been so caused to exist, and how their existence might be turned to beneficial account.

Youth, gentlemen, is especially the time for acquiring the habits of observation, as well as all other habits, and I desire earnestly to impress upon you, and upon all who have the training of the young, that, if ever scientific knowledge is to take a proper position in our midst, as it is doing in the rest of the world, it must be through training our youth to habits of correct, accurate, and minute observation. I call it a habit rather than a power of mind, and I think that any of you who have been in the company o a trained mind in any branch of science will readily admit the superiority—the vast superiority—of the trained over the untrained, in this apparently simple matter of observation. And let us, gentlemen, endeavour to disabuse our minds of the common idea that a fact to be worth recording must be something new, great, important, or peculiarly striking. The most important discoveries of science have had their origin in the observation of common, simple, overlooked facts. The waifs of ocean have told of worlds beyond, and of the winds and currents of the mighty deep; the boiling tea-kettle was the germ from which have resulted those mighty engines which have revolutionised industry and locomotion; and it was from the simple fall of an apple that Newton's master mind deduced the great law of gravitation. The apparent smallness of a fact is no criterion of its value. The want of a single nail in the construction of a mighty ship—the absence of a single stone in a great building—may endanger the safety of the whole structure. He who records a previously unobserved or unregarded fact, however small, has contributed one stone, which, in the hands of a master builder, may yet become the very keystone of an arch in the great temple of knowledge, but which, we may be sure, will find its appropriate place in that mighty building.

Let this thought, then, encourage some to contribute to our stores who might otherwise fear to do so. For, whilst there is nothing in nature so great, no laws so hidden that science dares not to grapple with and search after, still there is nothing so patent or so insignificant as to be unworthy of her attention. I would, therefore, earnestly urge you gentlemen, who have not yet taken an active part in our meetings by contributing the results of your observations or experience, to do so. Your mite may not be the least valuable of our stores. And, while directing your attention to the importance of cultivating habits of observation, even of the most trivial facts, and of the importance of recording them, I would also call your attention to the exceeding value of systematic observation—the observation of special classes of phenomena. In order to develope any

faculty to a high degree of perfection, it is necessary to apply it—not to everything that comes within its range, but in the first instance to a certain limited sphere. Trained to proficiency within that sphere it becomes capable of applying itself successfully to other and wider spheres. So with the faculty of observation. He who attempts to observe everything that comes within his range of vision, will, if he truly aspires to proficiency, soon be disheartened by his failure—his little progress. With less ambition, or more self- complacency, he may be a general observer, but he will be but a superficial one, an inaccurate one, a mere smatterer in that branch of knowledge.

There cannot be in science an admirable Crichton—a man equally well versed in every branch of scientific knowledge. Nature is too large, man's life too small in its present state. The duration of man's life itself sets a limit to the comprehension of the little that is known in all the departments of science, even to the most gigantic intellect. We cannot conceive of a man combining in himself the knowledge of Herschel and Hooker, Lyell and Faraday, Humboldt and Bunsen. To great minds alone it is given to be proficient in one branch of science, and so to be able to seize and accept the results of other labourers in other branches, but without being able to follow them in all their processes. To ordinary minds, even when trained, it is only given to have sound knowledge, though neither extensive nor minute, in one branch, and a general knowledge of the results attained to in other branches. But common minds untrained can attain to but a superficial smattering of scientific knowledge, sufficient for conversation perhaps, but of little practical value, insufficient to enable them to be contributors to the great onward march of science. To become accurate observers and correct recorders, you must devote yourselves to some special class of phenomena. By so doing, you will soon find that the faculty thus concentrated has increased in power, and may be applied—nay, will involuntarily apply itself—to a wider sphere, instead of being weakened by a diffusion over too large a field at first.

But I feel the thought cross the mind of some of my hearers, "Well, I should like to contribute my quota, however small, to the objects of this Society; but what can I do? Worried with business, the cares of my office, or my shop, or my family, leave me no time to devote to the active pursuits of science. I can only hope to read or hear the results which others accomplish." No doubt to some extent this is true, especially in this community, where wealth, not wisdom, seems to be the grand desideratum. But, I answer that, if you will but look on the fair face of nature with a loving eye, she will soothe your worried brain, and unfold peeps of her treasures to you. Have you not observed in walking home from your office or warehouse, how some plants flourish in this locality, others in that? Have you noted that, as you looked at your barometer on a cloudy morning, it was falling, and yet a fine day resulted; whilst sometimes it was rising, but the rain came down? Did you observe that moth that came fluttering round your lamp? It was a rare one not formerly known in this locality. Your field of rye grass has failed,—have you noted the conditions of soil and season, and other matters; or have you not just put it down to bad seed? These few illustrations I give to point out that even those with least opportunity may nevertheless be observers and contributors to the stores of knowledge which we desire to accumulate. And you will, perhaps, pardon me if I detain you a little longer in pointing out somewhat in detail the various subjects to which, especially in this country, you may profitably direct your observations.

Each may select that branch most congenial to his tastes and circumstances, and pursue that systematically, meanwhile seizing, as they pass, facts which in other branches happen to take his attention. In astronomy, the most ancient of sciences, not much may be accomplished without appliances, leisure, and training, such as, I fear, are not at the command of many amongst us. Still, in the kindred branch of meteorology much may be done in the way of observation and recording facts, and even in drawing deductions from these facts. The differences of temperature and of climate in places but little distant from each other, the causes of such differences, such as the proximity of the sea, the intervention of ranges of hills, the exposure to a particular aspect, the existence or non-existence of forest or swamp in the neighbourhood, the effects of such differences as shown by the vegetation or peculiar phases of animal life,—these afford wide scope for the exercise of careful observation, as well as of wide generalization. Practically useful, too, they will be in guiding the settler in his choice of locality for settlement, as well as in guiding him to the seasons, and to the crops which will best repay his exertions. In this branch, also, the observation of the indications of the barometer, whether ordinary or aneroid, in various localities, with relation to the direction or intensity of the winds, the season of the year, and other circumstances, would be valuable as guides to the traveller and the farmer.

In botany, though much has been accomplished by previous observers, still much remains to be done. Isolated localities alone have been thoroughly explored, and the discoveries during the past year by our worthy Secretary of so many new plants and new forms of known plants, during the rare opportunities he has had of systematic search,

should convince any of you with botanic predilections, that sufficient remains to be discovered to encourage you to devotion to that special line of investigation. Besides, the conditions that determine the distribution of plants in different localities presents a wide field for the exercise of thought, and none more practically important than that of the cause of grassed lands existing in some portions of our country, whilst fern lands predominate in others.

In chemistry, as in astronomy, I fear little can be hoped for; although with sufficient time, training, and appliances, I believe there is a wide field here open for the chemist in developing the natural wealth in our midst, in the way of dyestuffs, medicinal herbs, and other vegetable products.

In regard to the geology of our country, much, very much remains to be done, notwithstanding the valuable researches of Drs. Hector and Hochstetter, They have but dealt with general outlines, with the larger aggregated facts of geological formation, but in the details of every different locality, a vast work still remains to be done, a work which I feel sure will amply repay every care bestowed upon it. A series of specimens of the rocks found in every different locality, with a note of their positions in relation to other rocks, and to the contour of the surface, would indeed be a most valuable contribution to science and to our Museum, and would tend in no small degree to throw light on many obscure questions as to the past of our colony, as well as to guide us to the future capabilities of the various portions of it. In the observation, too, of facts in mining, mineralogy, and metallurgy, I would invite the attention of some of you. With such large mining interests as we now possess, and with so large a body of our population engaged in mining pursuits, I think we might reasonably expect contributions on these subjects. The depths of shafts in various localities, the direction of drives, the nature of the strata passed through during these operations, the position in which gold is found, the nature of the veins, leaders, or reefs in which it is found, their direction and inclination, and specimens of the gold-bearing strata of their adjacent casings, would indeed be a contribution to our knowledge, not only of scientific, but of great practical value. The processes, too, adopted for the extraction of the ore, observations on the defects of existing processes, suggestions for improvements, these would be of great value both scientifically and practically.

In regard to mechanical science and engineering, it may at first be supposed that in the face of the great mechanical knowledge, activity, and ingenuity of the old world, we cannot hope here to aid. But with the example before us of what has been, and is being accomplished in the young country of America, I see no reason to despair of our producing mechanical and engineering adaptations suitable to our own circumstances, which could not emanate from the older countries. And the discovery of a new adaptation of a known principle, is almost equally valuable with the discovery of a new principle. There are, I fancy, in this colony very many branches of industry in which the ingenious application of mechanical powers would make that profitable which is now unprofitable.

I am well aware that no amount of advice can create invention—necessity alone is its mother—but when we look to the vast number of useful inventions, to which, in America, that mother has given birth, and when we look to the necessity that in our colony exists for labour-saving machines, I would fain indulge the hope that even the stimulus of our Society may have some effect in finding a paternal ancestor for some useful mechanical inventions. To one member of our Society, at least, belongs the honour of having led the way in this department, in one prosperous and progressive branch of industry—I may almost now say of national industry; I mean in respect of machinery for the preparation for market of our *Phormium tenax*. Are there not other branches of industry which would be equally benefitted by the application of a little mechanical skill and invention? In mining especially—in agricultural operations more especially, I venture to say there is a wide field open for the application of mechanical and engineering science. And this leads me to one of the most important branches of science for a colony like our own. I mean agricultural science.

The most ancient of all *operations*, agriculture is one of the youngest of the sciences. In this colony agriculture has been treated too much as it has been in past ages, rather as a sort of operation to be performed by orthodox means with an *uncertain* result, than as a scientific operation to be conducted on ascertained principles, and producing, when so conducted, a *definite* result. From haphazard farming we have had even in this province too many melancholy specimens of pecuniary ruin; until agriculture takes its legitimate place as a science we cannot hope it to be other than a record of manifest failures and of unaccountable successes. It is true that your typical farmer is of the most conservative type, and scouts the notion of science as applied to farming. He points to this, that, and the other prosperous farmer, who, without an atom of scientific knowledge has been successful, and to this, that, and the other professedly scientific farmer, who has gone to the dogs. But it is not so—the high farmer is not necessarily the scientific farmer. The prosperous farmer, without scientific knowledge, is one who has by intuitive perception seized and applied practically what science would teach the reason

of; and our desire should be to reduce to law and order those things which have made the one successful by accident, so that all engaged in the like pursuits may have the benefit of that which has made the one successful. I do most earnestly ask our farming friends to contribute to us, whether they join us as members or no, the result of their operations, whether successes or failures, and the processes and conditions which have led to these results.

If I might be permitted to particularize on a subject of such importance, I would specially ask for observations of facts in reference to the growth of, and substance afforded to stock by the various grasses in our various soils. I would direct particular attention to the alleged failure of perennial rye grass seed, so as to determine whether the failure is owing to soil, climate, season, or other conditions. Only I would observe that what we want are *facts* not *opinions*—the latter can be had abundantly—the former is what we want. And so in regard to other crops. When a good one is grown of wheat, oats, or potatoes, or a bad one, we shall ask a contribution of the facts and circumstances, the soil, its previous culture, the subsoil, its nature and distance below, the season, and the culture; having these, we may, perhaps, be able to deduce general laws which would prove valuable to our country settlers, and especially to new settlers; not that we would desire to trench on the domains of our cognate society, the New Zealand Agricultural Society. Their business is more especially with results; ours is to work up from the results to the effective cause, thus making the result, if successful, available to, if unsuccessful, avoidable by, the mass of our settlers.

And here I cannot help adverting to the comparative apathy with which the liberal offer of the Colonial Laboratory to analyse soils gratis has been responded to by our country settlers. An hour or two's labour would enable every farmer to know the composition of his soil, a little more investigation would teach him wherein his soil was defective for the growth of certain varieties of plants, and would guide him with considerable certainty, not by rule of thumb, to apply stable manure, bone-dust, guano, phosphates, or other manure to his land, so as to supply the missing or defective element in its composition.

Pardon me, gentlemen, if I have dwelt too long on agriculture, but I feel that the products of the soil, whether in the shape of grain, wool, grass, meat, or minerals, are the fundamental elements of our colonial prosperity, and as such deserve our most special attention. And very nearly allied to agriculture, as a science, is the study of zoology. A strange combination it may appear to some, and yet when we look at what our farmers have suffered and will yet suffer, I venture to say, from the ravages of insects, it is not such a strange combination of ideas as it seems. We have, indeed, endeavoured in a sort of perfunctory manner, to cope with these insect enemies by the introduction through the Acclimatisation Society of insectivorous birds. And yet how many questions has this same action given rise to? What are the habits of our birds? First, of our native birds —the morepork, the kingfisher, even the hawk. Then of our introduced birds, whose habits in their native habitat we know, but what are their habits in the altered circumstances in which they are placed; for instance, are our pheasants more insectivorous than graminivorous? still an open question, I believe; and so, also, with regard to other birds: and then comes the higher question of the adjustment of good and evil; for what seems good is not all good, and may become an evil, and what appears to be an evil has good in it, too, and may be turned to good account. These only can be determined by a series of accurate observations.

In reference specially to the insect life of New Zealand we are comparatively ignorant, and so we shall be till some one breeds from the caterpillar (the easiest obtainable form) the chrysalis, and from thence the moth or butterfly; and thence obtains the larvæ of the caterpillar, and observing their habits in their various stages, enables us to determine the appropriate remedy for their ravages. I specially commend this branch of scientific enquiry to those whose position or habits enable them to indulge in a country or suburban life.

But passing from those more apparently practical applications of scientific enquiry to others but little less so, though less apparently so, I would point out to you that much yet remains to be determined in New Zealand, even geographically. Even in this province, extending as it does from lat. 39° to the North Cape, there is a large portion of it quite a *terra incognita* save to a few. Might not those few, through our Society, make known their knowledge to the many? And even in the well-known parts there are facts as to the elevation and subsidence of the land, the creation of sandhills and their progress, and conditions; the occurrence of landslips and their conditions; the existence and shifting of sand-bars in or near our harbour, and their conditions; the existence, temperature, and qualities of hot springs in various localities; these and many other geographical and semi-geographical facts, would be well worth careful and systematic observation; but above all I would ask the members of this Society, and through them our settlers at large, to devote some little attention to the history, mythology, ethnology, and archæology of the native race. I do so specially, because they are rapidly passing away from under our observation, as well as because I believe there still exists a rich mine for investigation and

record. Whence came they? and when came they to these islands? are questions wholly undetermined, and we in this province have, I believe, alone the data for determining them.

To do so satisfactorily will require a large collection of facts. Their true history, so far as it can be ascertained; their mythical history, which is abundant if collected, as to some extent it has been in the records of the Native Lands Court; their traditions and poetry, which have been partially recorded by Sir George Grey and others; the construction of their skulls; the peculiarities of their language, which we may gain from Bishop Williams, Archdeacon Maunsell, Mr. Colenso, Mr. Davis, and others; the records of their existence and works, exhibited in their enormous *pipi* beds, and in their *hangis* all over the country; their terraces on Mount Eden, and the other volcanic hills of this isthmus; their stone axes; the shape and carving of their ornaments, their weapons and canoes; all these would tend to throw light on the history of the race; but more especially if any authentic account could yet be obtained of their ancient religion and rites, it would be most valuable, and worthy of preservation. In this branch of enquiry, we,—in this province—have advantages nowhere else possessed, and to us will belong the disgrace of allowing the records of the native race to perish, if we fail to record them. I ask you, therefore, gentlemen, to devote some part of your attention to this branch, and to put on record every fact, every tale, every tradition, that you may happen to become acquainted with.

There are various other branches of scientific enquiry to which I might direct attention,—biology, the science of animal life; psychology, the science of mind; and many others. But I fear I have already detained you too long with these discursive remarks of mine. They will, I trust, be received as I have intended them—as aids or guides to thought; as germs, which, finding a resting place in some minds, one here, another there, may produce fruit in the shape of contributions to our proceedings. And pardon me, gentlemen, for reminding you that over and beyond the mere natural pleasure which is to be obtained by the observation and contemplation of the wondrous records of nature, and over and beyond the practical utilitarian advantages to be derived from the study, there is the higher pleasure, the nobler advantage, of thereby bringing ourselves into nearer communication with the great Creator of all. They are His works, His handwriting, to be read and studied by all men, and though they, like His written word, may be misunderstood, or misrepresented, yet we believe that He will grant to the humble, earnest student, a knowledge of the truth.

The fallacy is now well-nigh exploded that the study of physical science tends to make men materialists, and to lead them to conclusions antagonistic to the teachings of revelation. This fallacy or prejudice has arisen in great part from the foolish idolatry with which we have long looked on the Bible as being *the* Word of God, instead of accepting it as what it professes to be, only *a* Word of God. As a recent writer well puts it, there in *one* only who is *the* Word. The records of nature are as truly His word as His written revelation, and are His own fingers' writing, not passed through the filter of human language, uncorrupted by age or translations, and are not *more* liable to be misunderstood or misinterpreted than what we have been accustomed to call *the* Word. Both being His words, they are complementary of each other; their teachings cannot be antagonistic; they will throw mutual light on each other. The humble student of nature will as surely be led up to a knowledge of, and communion with the great Father of all, as will the student of theology.

That we may be enabled to cultivate humility in our pursuit of knowledge is, I feel sure, your desire, as it is mine, that we may increase the numbers of our seekers after knowledge; that we may be able to contribute to the increase of knowledge is the object of our Society. A truly noble object it is, and we may well say with the poet—

> "Knowledge is of things we see;
> And yet we trust it comes from Thee:
> A beam in darkness let it grow:
> Let knowledge grow from more to more,
> But more of reverence in us dwell:
> That mind and soul, according well,
> May make one music as before,
> But vaster."

Gentlemen, I have much pleasure in now declaring the second session of the Institute open for transaction of business.

Papers read:—

(1.) "On the Puka *(Meryta Sinclairii)*," by T. Kirk. (See ante, p. 100.) The author exhibited specimens obtained from the Taranga Island, where he had recently discovered it.

Captain Hutton remarked that he had accompanied Mr. Kirk on his expedition to the Hen and Chickens in search of these plants, and they had found eight on one of the

Chickens, but they were unable to find any on the Hen. He thought it not improbable that those eight were the only plants of the kind in existence, and they were situated in such a position as to render them all liable to be destroyed by a fire, were such an accident to arise in consequence of fishermen touching at the island.

(2.) "On the introduction of the English and Chinese Pheasants into the Province of Auckland," by Captain Hutton, F.G.S. (See ante, p. 80.)

The Rev. T. Bruce inquired whether any attempt had ever been made to introduce the English pheasant into that part of the province lying south of Auckland, by conveying birds from Mangonui and liberating them in the neighbourhood of Auckland.

The President could not answer the inquiry of Mr. Bruce from his own personal knowledge, but he thought the subject was one which gave rise to several interesting questions. For instance, they had found from experience that, although the English pheasant bred much quicker than the Chinese when in confinement, when the birds were set at liberty the reverse was the case. Possibly they might at some future time have papers laid before them by other members which would deal with these questions.

(3.) "On the decrease of Honey in the Auckland Province," by R. Todd. Extract from a letter to the President:—"The natives inform me that it is no use looking for honey in the bush, that the nests contain no honey now-a-days. Can this be that the nature of the bee is changed—that finding flowers can be had at all seasons they lay up no store for the winter? The kakas, or parrots, and also the kakarikis, or small green parrots, are now very scarce, and rarely seen. The natives tell me the bees are driving them away by usurping their ruas, or habitats, and that consequently the kakas are decreasing."

Captain Hutton could not agree with the conclusions contained in the letter. He was doubtful, in the first place, whether honey was becoming more scarce in the bush, but, even were such the case, as the honey was stored for the young he did not think that the bees would trust to so uncertain a supply as they would be able to obtain from the flowers in winter. He was not quite sure whether the bees did not hybernate in winter. With regard to the bird mentioned by Mr. Todd, he had known instances where the birds mentioned were most plentiful during a season when honey was also abundant.

The President observed that bees certainly did not hybernate here during the winter, as on fine days during that season he had seen them buzzing about as much as in the middle of summer. He thought it was doubtful whether the bird spoken of by Mr. Todd could be called a honey-eating bird, for although it certainly did eat honey he had known in the South instances of whole fields of corn being stripped by it, and sometimes even the straw thatch torn off barns by flocks of the birds.

(4.) "On Artificial Stone," by Dr. Purchas. The author observed, that some time ago he had written to the Company which had been started in England for the preparation of artificial stone, making some inquiries regarding the solution required for the hardening of the material. The stone was coming into great use, and had been found much more durable and waterproof than brick. In reply he had received full information regarding the process, and would like a sub-committee appointed to investigate the matter, in conjunction with himself, with a view to bringing it under the notice of the Society. He had at first written inquiring into the system for the purpose of adapting it to the iron sand; but as the question of working the sand had been practically settled, it was not of much value for that purpose then. It might, however, be applied for the preservation of some public buildings, such as the Supreme Court, where he understood the Bath stone was crumbling away. The damp brick houses might also be improved by a coating of the solution. He had applied some of the solution to a small quantity of iron sand, a specimen of which he had brought for the inspection of the members, and from which it would be seen that the sand could be hardened.

The President thought the matter was more one for the consideration of the council of the Society than for a general meeting.

THIRD MEETING. *July* 5, 1869.

T. B. Gillies, President, in the chair.

The names of the following new members were announced:—Messrs. J. Roberton, J. S. Macfarlane, E. Wayte, F. E. Manning, D. O'Keefe, A. Lascelles, T. Morrin, G. M. Mitford, J. A. Wilson, J. M'Effer Shera, Major Mair.

A list of donations to the Museum was read by the Secretary.

Memoranda respecting the Tidal Phenomena observed in New Zealand in August last, compiled by Mr. J. M. Wayland, were read by the Secretary. (See Vol. i. p. 101.)

Dr. Purchas remarked that shortly after the time it occurred some very interesting accounts of the tidal wave appeared in the newspapers, and it would it be well if the Secretary could obtain these also, and preserve them along with Mr. Wayland's memoranda.

Mr. J. A. Wilson said he had made many inquiries amongst the old inhabitants about a wave that reached the Bay of Islands shortly after the great earthquake at Concepcion, but he had not been able to glean many particulars.

The Chairman said they could easily ascertain the telegraphic times of the late tidal wave's impinging on New Zealand, as these were recorded at the time, and transmitted to the General Government.

Papers read:—

(1.) "On the Surface-fall of Water, as a guide for Under Drainage," by J. Baber, C.E. (See ante, p. 213.)

Mr. Stewart, C.E., said Mr. Baber's plan was very good so long as the ground was pretty regular, but it would not do for a rolling field where the drains could not be put in. In all cases he was of opinion the chains should be placed as nearly parallel as possible, whether they were 3, 6, 9, 12, 15, 18, or 22 feet apart, and so on, but not at right angles to the contour. The smaller drains might be of one and a-half inch tiles, and the larger of three inches, with a main drain also at right angles. The object of a drain was not only to take water off the surface, but also to let water and air into it.

Captain Hutton was disposed to agree with Mr. Baber, for if the ground was steep and the line of swiftest descent chosen, the drains would speedily choke.

Mr. Buckland said they might place their drains as they pleased, but water would go downhill, and the steeper the quicker.

Mr. Baber: But suppose you have a hill?

Mr. Buckland: We take them round a hill, and then we must take off the water slowly. One of the greatest difficulties was when they came to a land spring; they must tap that.

Mr. David Hay said they would find a good guide to draining in the vegetation that grew on the top of it. No general rule could be laid down, however, except for clay soils, and for these only if of an equal medium. Sometimes they were placed 15 or 20 feet apart, according to the quality of the soil. All drains should be angled where the ground was steep, but those drains that were semi-circular had been found to draw better. The ditches should also be well scoured out, and wells sunk at the mouth of each drain. It was well known that drained ground was several degrees warmer than the undrained, and where air and moisture got to the roots of plants vegetation proceeded better.

Mr. Buckland said he believed that deep drains, or any kind of drains, were of little value unless they also subsoiled the ground. In the neighbourhood of Mangere it had been observed that the drains did not carry off the water as before, and the cause, he thought, was that the land had been "puddled" by the cattle. The effect of draining on the potato crop was in some cases very remarkable. Immediately over the drain the potatoes were saved, while all around they were lost with rot for want of proper drainage. He doubted if Mr. Baber's theory could be reduced to practice, for nothing, in his opinion, could regulate drainage but the gravitation of the water.

Mr. Boardman said they had just heard two statements that he could not reconcile. Mr. Buckland said the potatoes were saved by being over the drain, and yet Mr. Stewart said they were required to put water into the ground. Now, there was no logical sequence in the two statements, for on Mr. Buckland's theory the potatoes supplied with the additional water would rot.

Mr. Stewart: But when sub-soiling and deep-drainage are carried out, the sub-soil becomes the right soil, and the surplus water is taken off by deep drains.

Captain Hutton said, with reference to the remark of Mr. Buckland that deep drains did not carry off water now so quickly as formerly, he might observe that the surface of the volcanic soil of New Zealand was not soil, but soil in the process of formation. Volcanic soils do not decompose very rapidly, as we see at the Shortland diggings, where the soil is a tenacious mud. Where the soil is light and porous, drainage is easy, but light volcanic soils will get heavier; and he thought, if the drains alluded to by Mr. Buckland were too far apart, that would account for the difference.

Mr. Baber said that drains should always be at right angles to the contour of the land.

The Chairman said that no rule was applicable, but there were a few general rules that might serve as a guide. Mr. Baber's plan not to run the drain straight across had not been well understood, but these drains would then lie in the line of steepest descent, while, by placing them at right angles to the contour, Mr. Baber only stated what was in harmony with a general law.

(2.) A communication from Mr. Hawkins, North Shore, relative to the decrease in the quantity of honey found in beehives was read by the Secretary, in which the author gave, as his opinion, that the reason was owing to the honey-producing shrubs being destroyed by browsing, and that the honey-yielding districts had become overstocked with bees.

Mr. Buckland said his son was a bee-man, and his experience corroborated the observations that had been made this night, and at previous meetings. He had found

that the bees only produced as much honey as would keep the young bees alive, and therefore when he found the bees were not making honey he removed it.

Dr. Horne said he did not think it was so much owing to the browsing of the cattle as to certainty of food at all seasons. The very same thing had been observed in New Plymouth, when he first settled there. The bees had plenty of clover, and when they found that they could get honey in the winter as well as in the summer they did not lay up any.

(3.) "On the Latent Heat contained in the aqueous vapour in the Atmosphere," by J. A. Wilson.* This paper had appeared in the form of letters in the "Daily Southern Cross," of November 19, 1864, and of December 24, 1864, under the heading, "Remarks on Australian and New Zealand Climatology, relative to our droughts, rains, and hot winds." In his introductory remarks, Mr. Wilson said that his opinions on the subject were almost identical with those laid down by Professor Tyndall, in his famous lectures on heat.

Dr. Purchas said he had observed one kind of rain upon the leaves of plants, in very large drops overhanging the edges of the leaves, and he could not say what was the reason of it.

Mr. Stewart said there might be a difference in the leaves; if there was any in the rain it would show in analysis, and might depend on the atmospheric state at the time, and it might have a different effect on different plants. Mr. Wilson's paper had been most admirably got up, and would require much time for discussion. With reference to steam, the latent heat depends on the pressure of the steam, and it was ascertained by the greater quantity of water that would be required to reduce the steam to a working temperature, say of 100 degrees, and this even though the pressure of steam may be reduced by expansion.

Dr. Purchas said that we must recollect that steam at high pressure was a different thing from steam at low temperature. High-pressure steam dissolves silica in caustic soda, but low-pressure steam will not. As for the rain on the leaves, kind has nothing whatever to do with the leaf, it is a peculiar description of rain, almost always accompanied by sickness. When it happened he always observed there was something very peculiar about the condition of the atmosphere.

Mr. Peacock said it was a very valuable paper that Mr. Wilson had just read, and would require consideration for some time. In reference to Mr. Stewart's remarks upon steam, he, Mr. Peacock, was of opinion that the latent heat was not solely due to the pressure.

Mr. Stewart said his remarks had reference to steam produced in a partial vacuum, where it could not flash like gunpowder into vapour at once. Ice would not immediately dissolve when dropped into boiling water—latent heat requires some time to be reduced. It was latent not so much in a partial vacuum, and conversely much more in a high-pressure boiler.

Mr. Wilson said Professor Tyndall gives latent heat as equivalent to concealed heat, and he speaks of potential heat, possible heat, possible energy, possible power, dynamical energy, which is temperature, etc. In lifting a weight, for instance, a certain quantity of heat was expended in the action of drawing the arm up. We might speak of the difference between two substances, and the atoms in that substance. Weight has a power —a possible power. And if we take water, heat is a potent power in that substance, keeping apart the molecules, and expanding it. When the potential energy passes off, the actual energy takes place. Steam, for instance, can be evaporated at 32°, as well as at any higher temperature.

Captain Hutton said the paper was a most valuable one, and it was certainly a curious question how the rain drops were so large when they fell, and how they came to grow so rapidly in falling.

After some further remarks the meeting adjourned.

Fourth Meeting. *August* 16, 1869.

T. B. Gillies, President, in the chair.

The names of the following new members were announced:—Dr. W. W. Watling, Dr. B. C. Beale, Dr. S. H. Ford, Mr. F. H. Meinertzhagen.

A list of donations to the Museum was read by the Secretary.

Papers read:—

(1.) "On the Geology of the North Head of Manukau Harbour," by Captain Hutton, F.G.S. (See ante, p. 161.) The paper described the formation of the locality treated upon, which is composed chiefly of volcanic rocks. It contained an interesting

* Sent to author for revision, 26th January, 1869; not yet returned, March 25.—Ed.

account of the bearing of the lava streams and trachytic dykes, and treated of the resemblance which a portion of the district bears to the formation upon which Shortland and Grahamstown are built.

(2.) "An account of a remarkable Phenomenon observed at a Hot Spring near Lake Taupo," by Captain J. G. Corbett. The phenomenon described occurred on the 3rd of January, 1869, about eleven o'clock in the evening, when the writer was disturbed in a whare near Lake Taupo by a sound resembling the rushing of a strong wind. On going outside he observed a large column of vapour, which was being ejected from a hot spring near at hand, to a height of 200 feet.

The President remarked that the natives assigned the rise and fall of the waters in the chain of Rotorua Lakes to atmospheric causes.

Mr. Wilson observed that there was little doubt that the meteorological conditions had a considerable influence on the hot springs, but it was difficult to define their exact action. He questioned whether the greater density of the polar over the equatorial winds would be sufficient to account for all the changes in the state of the springs. The wind had a different effect on different springs at the same time. In some cases the tendency of an equatorial wind was to depress and in others to expand the waters. The condition of waters of the various springs, too, was not uniform, some being largely charged with mineral matter, while in others it was almost totally absent. They were also largely charged with gases, which he believed had a considerable influence on the eruptions, and if a light were applied to the waters of some a flame would be observable from the combustion of the gas emitted. A fire lighted near the springs would also at times have the effect of causing an eruption, but whether the result was brought about by the expansion of the steam or gases by the heat, he had not sufficient data to decide. Within a few miles of the spot indicated by Mr. Corbett, he had before seen eruptions, but he thought that the action of the geysers was subsiding.

(3.) "On the Grasses and other Plants adapted for pasturage in the Province of Auckland," by T. Kirk. (See ante, p. 102.) In this paper the author described the most suitable native and introduced grasses, which were carefully classified for the benefit of the agriculturist and botanical student. The paper contained a mass of information on the subject, which would prove most useful to those interested in pasturage.

Mr. May suggested that it would be most advantageous were the Acclimatisation Society to plant various patches of different kinds of grasses to ascertain which sorts are best adapted to the climate of the colony.

Fifth Meeting. *September* 20, 1869.

T. B. Gillies, President, in the chair.

The names of the following new members were announced:—Messrs. E. Maclean, J. Gwynneth, H. Williams, and H. Campbell.

The list of donations to the Museum during the past month was read by the Secretary.

Papers read:—

(1.) "Description of *Nyroca australis*, Gould, and *Æstrelata Gouldii*, Hutt., n.s., two Birds new to the Fauna of New Zealand," by Captain F. W. Hutton, F.G.S. (See ante, p. 78.)

A specimen of *Æstrelata Gouldii* was exhibited.

Mr. Kirk remarked that it was barely possible the *Æstrelata Gouldii* might be identical with the original *Procellaria macroptera*, the differences being those of age only. The description in each case was drawn from a single specimen. It must, however, be pointed out that this view was scarcely supported by the relative measurements of the two forms.

(2.) "On the occurrence of Orobanche, a genus new to the Flora of New Zealand," by T. Kirk. (See ante, p. 106.)

(3.) "Description of the Lava Caves at the 'Three Kings,' near Auckland," by James Stewart, C.E. (See ante, p. 162.)

(4.) "On the Comparative Performances of certain River Steamers on the Waikato," by James Stewart, C.E. (See ante, p. 220.)

(5.) "Diary of a Canoe Voyage up the Waikato and Waipa Rivers, in September and October, 1852," by the late Dr. Sinclair,—read by the President. (Reserved.)

SIXTH MEETING. *October 18, 1869.*

T. B. Gillies, President, in the chair.

The names of the following new members were announced:—Dr. Nisbett, and Mr. J. H. Upton.

Mr. Gillies said the first business they were called on to transact was the election of one of the members to vote for the governors of the New Zealand Institute: when the affiliated societies numbered only three, each elected a governor; but when they exceeded that number, each must nominate one of its own body.

Mr. Whitaker proposed "That the President be nominated to vote on behalf of the affiliated society, for a governor of the New Zealand Institute." Major Heaphy seconded the motion, which was unanimously agreed to.

A list of donations to the Institute during the last month, was read by the Secretary, among which was, a magnificent specimen of auriferous quartz, from the claim of the Long Drive Company; also, very curious specimens of crystallised auriferous quartz, from the claim of the Una Company—these were a blue casing, with white crystals, the gold being scattered upon it like spangles. Also, specimens of auriferous quartz from the gold mines of Hungary and Transylvania.

Captain Hutton said the specimens exhibited had been sent to him by Dr. Hector, who, he believed, had received them from Dr. Haast. They corresponded very nearly with the auriferous rock of the Thames, except that there was rather more silica in the European specimens. Although there might be more valuable minerals in a specimen from one place, more than was to be found in a specimen taken from a different place, yet that did not alter the description under which the stone might be classed. There was more lead and silver found with gold in the Hungarian mines than was found here, so much that the silver mines had become more valuable than those which produced gold. The stone exhibited was described as volcanic tufa, by the Imperial Survey of Austria. He believed there was a good deal of controversy in reference to the subject, but he thought the Survey Department of the Austrian Government had much better means of knowing, and were more likely to be correct, than private individuals.

Papers read:—

(1.) "On the Discovery of Isoëtes, and other genera of Rhizocarpæ, new to the Flora of New Zealand," by T. Kirk. (See ante, p. 107.)

(2.) "On *Epacris purpurascens*," by T. Kirk, who exhibited several specimens of this plant, which had been first observed by Dr. Sinclair, in the neighbourhood of Papakura, to which locality it appeared to be confined. (See ante, p. 107.)

(3.) "On the Structure of the Leaf of *Phormium tenax*," by Captain Hutton, F.G.S. (See ante, p. 111.)

(4.) "On the New Zealand Flax (*Phormium tenax*)," by Major Heaphy, V.C. (See ante, p. 116.)

Archdeacon Williams, Captain Hutton, Captain Heale, and Major Heaphy, V.C., took part in the discussion which followed the reading of these papers.

The President urged that more papers such as that by Captain Hutton were much wanted. At present, there seemed to be no agreement as to even the names by which the different varieties of flax were known to the natives.

Captain Hutton said that, whatever kind might be chosen for cultivation, whether "tihore" or some other, years must pass before it could be of commercial importance. The common flax would have to be depended on for some time to come. The "tihore" was so rare at present, that unless a very much higher price than ordinary could be obtained for its fibre, it would not pay anybody to deal with that plant by itself. Was "tihore" ever found wild?

Major Heaphy, V.C., said that he had found it in parts of the island which had not been inhabited or cultivated for many generations. It was to be found in one part of the Domain, on the left from Mechanics' Bay, but he had found at the roots of the plants the shells of edible fishes, showing that the natives had been there.

Captain Heale said that he believed it would be found that very much which was known as to flax had been forgotten. In 1841, there was at Rugeley, in Staffordshire, a factory specially for the manufacture of canvas, etc., from New Zealand flax. It happened thar he became possessed of £100 worth of that canvas; and a schooner which he had was fitted with a complete set of sails out of that canvas. He was not sure that he did not still possess, in England, some cambric handkerchiefs, made of flax; and in France, flax was at that time much used for covering the wood of tassels, because the fibre took dye to perfection, and, at a short distance, when so used, could not be distinguished from silk.

The Secretary thought it doubtful whether, for commercial purposes, the fibre of any particular variety of flax would be found to have a decided superiority over that of the common variety.

Specimens of the principal varieties of flax were exhibited by Captain Hutton.

Seventh Meeting. *November* 15, 1869.

The Rev. D. Bruce in the chair.

The names of two new members were announced :—Messrs. Hugh Hart Lusk, and George Thompson Chapman.

A list of donations to the Museum was read by the Secretary.

Papers read :—

(1.) "On the occurrence of the New Zealand Frog (*Leiopelma Hochstetteri*) at the Puriri Creek, Thames ; with an Account of a peculiar feature in the habits of an Australian Frog," by Alexander Aitken, second officer of the late Victorian Exploring Expedition. (See ante, p. 87.)

A specimen of *Leiopelma Hochstetteri*, from Puriri Creek, accompanied the paper.

(2.) "On Drainage Operations at the Remuera Swamp," by J. Baber, C.E. (See ante, p. 219.)

In the course of the discussion which ensued, Mr. Baber drew attention to the numerous subterranean currents of water in the lava field of Mount Eden, and which formed the source of supply to the swamps and streams having their outlet at Coxe's Creek. Certain wells in the Epsom district appear to tap these streams, as they are never dry, while other wells, within a few yards even, and at much greater depths, are often dry.

Dr. Purchas remarked that after the floods of Ash Wednesday last, when the traffic was stopped at Penrose, new springs broke out in Onehunga, and continued in operation for some time. Wells sunk through the scoria in Onehunga yielded at the same level; but there was a difference of ten or twelve feet in the height of the water during the summer and winter seasons. A lava field was like a vast sponge, collecting the surplus water of the winter and storing it for future use.

Mr. W. Buckland considered that the flood at Penrose was in all probability caused by the discharge from the Ellerslie slaughter house having blocked up the usual outlet from St. John's Lake, and forced it to seek another channel.

Dr. Purchas said that Mr. Buckland's statement at once explained what had been a great puzzle to the inhabitants of Onehunga ; their water supply, usually remarkable for its extreme purity, had of late been slightly tainted.

(3.) "On the Naturalized Plants of New Zealand, specially with regard to those occurring in the Province of Auckland," by T. Kirk. (See ante, p. 131.)

Mr. W. Buckland observed that he had lately observed the so-called Chilian groundsel in great abundance, and of unusual luxuriance near Taupo. He should like to know if Mr. Kirk considered the Rat's-tail grass native or introduced.

Dr. Purchas remarked that he had listened to the reading of the paper with great interest, and trusted the interesting questions it suggested would receive the attention they merited from members of the Institute during the recess.

Mr. Kirk stated that the so-called Chilian groundsel was *Erigeron canadensis*, a native of North America, which, since the middle of the seventeenth century, had spread over the world. The Rat's-tail grass was *Sporobolus elongatus*, and he believed it to be a true native ; although an exotic grass, *Selaria italica*, which Mr. Bassett informed him had been introduced within the last ten years was often growing with it in the Otahuhu district. He pointed out the value of records of the first appearance of naturalized plants in any district with regard to the important subject of their powers of diffusion, and urged the members of the Institute to place facts of this kind upon record.

(4.) "On Improvements in the Processes for extracting and saving Gold," by T. Heale, C.E. (See ante, p. 174.)

Dr. Purchas remarked that he considered the mode of assay and separation, suggested by the author of the paper, just read, not only feasible, but the best that had been proposed ; it was, in fact, identical with the first process employed by Mr. Ransen, in the production of his patent concrete, he dissolved flints in caustic potash under pressure ; and auriferous quartz differed essentially from flint only in the presence of metals.

Mr. James Stewart spoke of the ease with which pressure could be applied by means of steam ; the material to be operated upon being placed in iron retorts furnished with safety valves, and surrounded by clay. He believed that specimen-crushings would never take place if this plan were adopted.

Mr. W. Buckland considered that most of the gold lost in the process of extraction was lost from its connection with pyrites, and therefore that the results of Mr. Heale's plan would be nil. He believed that twenty-five per cent. of the entire quantity of gold in the quartz was lost from this cause.

Mr. Heale did not believe that so large a proportion of gold was lost at the Thames, except under special conditions ; his impression was that with the general run of stuff the gold was extracted fairly, perhaps not perfectly. It was at times difficult to ascertain

when low returns were to be referred to imperfect machinery, and when to inferior qualities of material. He had seen gold which yielded fifty per cent. of silver.

The Chairman remarked upon the importance of the members of the Institute working, during the recess, for the furtherance of the objects for which it was formed, and declared the second session of the Auckland Institute to be closed.

PHILOSOPHICAL INSTITUTE OF CANTERBURY.

SESSION OF 1868-9.

PROCEEDINGS.

GENERAL MEETING. *November* 4, 1868.

J. Haast, Ph.D., F.R.S., President, in the chair.

On the motion of Mr. Nottidge, it was resolved,—"That in the opinion of this meeting it is desirable that the rules be revised, and that the Rev. James Wilson, and Messrs. Davie, Fereday, and the mover, be appointed to draw up new rules, and report to the next meeting."

Papers read :—

(1.) "On the removal of the left upper jaw, for Cancer," illustrated by photographs, by J. S. Turnbull, M.D.

(2.) "On Delirium Tremens," by J. S. Turnbull, M.D.

(3.) "On the earlier Earthquake Waves observed on the coast of New Zealand," by C. Davie, Chief Surveyor. (See ante, p. 222.)

SECOND MEETING. *December* 2, 1868.

J. Haast, Ph.D., F.R.S., President, in the chair.

The President (Dr. Haast) laid before the meeting "Maps of the World," and "Charts of the Stars," by Colonel Sir Henry James, which had been presented to the Institute by Mr. W. Packe.

The Secretary stated that a number of scientific works had been lent to the Institute by Dr. Powell.

Papers read :—

(1.) "On four fishes commonly found in the River Avon; with a consideration of the question, What is Whitebait?" by Ll. Powell, M.R.C.S.St.A. (See ante, p. 84.)

A discussion ensued, resulting in the following motion by Dr. Turnbull, being carried:— "That Messrs. Davie, Fereday, and Nottidge be appointed a committee to watch over the progress of the fishes mentioned in Dr. Powell's paper, and also specially to carry out the two suggestions with which the paper terminated."

(2.) "On a new species of Seal," by the Rev. C. Fraser, M.A., F.G.S., who identified it with the genus *Stenorhyncus leptonyx*, but suspected it might ultimately be established as a distinct genus. (See ante, p. 33.)

(3.) "On the Geographical Distribution of Plants in New Zealand," by J. Haast, Ph.D., F.R.S. This paper was introductory to one by Mr. J. F. Armstrong, "On the Vegetation of the neighbourhood of Christchurch, including Riccarton, Dry Bush, and Hoon Hay Bush," which was next read. (See ante, p. 118.)

On the motion of the Honorary Secretary (Rev. C. Fraser), it was resolved to refer to the Council, the consideration of how Mr. Armstrong might be induced to prepare and publish an account of the Botany of the Christchurch District, and to what extent the Institute should be prepared to contribute towards the expenses of the publication.

Third Meeting. *March* 17, 1869.

His Honor W. Rolleston in the chair.

Messrs. J. E. Fitzgerald, and L. C. Powell were elected honorary members of the Institute.

Eight volumes of a Catalogue of the Fishes in the British Museum, being a present from that Museum to the Canterbury Museum, were laid on the table.

Paper read :—

"An Enquiry into the applicability of the Doctrines of Political Economy to Colonies," (Introductory), by J. S. Turnbull, M.D.

Fourth Meeting. *May* 5, 1869.

J. Haast, Ph.D., F.R.S., President, in the chair.

Mr. Edward Dobson, C.E. (late Vice President) was elected an honorary member of the Society.

On the motion of the Honorary Secretary (Rev. C. Fraser), it was resolved,—"That an address from the Council of the Institute should be sent to Mr. E. Dobson, on the occasion of his election as an honorary member.

On the motion of the Honorary Secretary, it was resolved,—"That it is desirable to make the year of the Institute commence with January 1st, and terminate with December 31st, and that, in order to arrange this, members be requested to pay a subscription of one guinea for the half year, ending 31st December, of the current year."

Paper read :—

"On a specimen of *Berardius Arnuxii*, or Ziphid Whale, captured at New Brighton," by J. Haast, Ph.D., F.R.S. (See ante, p. 190.)

The Honorary Secretary (Rev. C. Fraser) drew attention to the improvements made by Mr. G. Cawood upon the nautical compass ; and the following resolution was adopted: —"That Messsrs. Jollie, Davie, Triphook, and G. W. Hall be appointed a Committee to confer with Mr. Cawood respecting his alleged improvements upon the nautical compass."

Fifth Meeting. *June* 2, 1869.

J. Haast, Ph.D., F.R.S., President, in the chair.

The President laid on the table a copy of the report of the Government Botanist and Director of the Botanical Garden at Melbourne, for the year 1868.

Mr. E. Fereday exhibited some specimens of the *Sesia Tipuliformis*, a species of what are commonly known as Clear-winged Moths, which are very destructive to currant bushes.

The Secretary laid on the table copies of the "Transactions and Proceedings of the New Zealand Institute, Vol. i., 1868."

Papers read :—

(1.) "On a Collection of Saurian Remains from the Waipara River," by J. Haast, Ph.D., F.R.S., who described the animal as belonging to the Amphisulia, animals of a more fish-like character than the existing crocodiles, and marine in their habits. In addition to a drawing of certain remains sent to England by Mr. J. H. C. Hood, some organic remains were exhibited, including a vertebra of a Plesiosaurus found near the same place, with portions of femur, tibia, and paddle bones. (See ante, p. 186.)

(2.) "On University Education, as adapted to the circumstances and prospects of the Colony of New Zealand," by the Rev. C. Fraser, M.A., F.G.S. (See ante, p. 192.)

A lengthy discussion ensued, in which the Rev. Canon Wilson, the Rev. C. Fraser, Dr. Turnbull, Dr. Haast, and Messrs. Tancred and Davie took part.

Sixth Meeting. *July* 7, 1869.

J. Haast, Ph.D., F.R.S., President, in the chair.

The report of the Council, for the year ending June 30, 1869, was read by the Honorary Secretary (Rev. C. Fraser), and on the motion of Mr. F. E. Wright, was adopted. The following is an abstract :—

The Council in presenting this report to the members of the Institute, feel that they have just cause for congratulation in the marked success which has attended the meetings of the Institute throughout the year, and in the increased number of members.

One of the most important events connected with the Institute has been its incorporation with the New Zealand Institute under the Act of the General Assembly, by which that Society was established. Among the conditions of incorporation it is stipulated that one-third of the annual income of the Institute shall be devoted either to a local Museum or Public Library, or that one-sixth of the income shall be remitted to Wellington, to be expended there upon the Colonial Museum by the Governors of the New Zealand Institute. In accordance with this condition, one-third of the income of this Institute has been appropriated to the Museum under the direction of the President (Dr. Haast). The Council are persuaded that the members of the Institute made a wise selection in determining upon this object. They have helped to promote the efficiency of an institution which must always be of the highest value in the prosecution of scientific researches, and which is intimately connected with the immediate objects of the Institute itself.

The establishment of the New Zealand Institute, with which this Society is now incorporated, must be regarded as of especial importance, as forming a bond of connection between the various local scientific societies of the colony, and as introducing an element of permanence, which has hitherto been wanting to their efforts. The publication of a selection of the papers read before this and similar societies is a further benefit of which the members have a valuable proof in the recently published volume of the Transactions of the New Zealand Institute.

The efforts made by the President (Dr. Haast) to supplement the vote passed in the Provincial Council for the erection of new buildings for the Museum, are deserving of special notice in this place; the subscriptions obtained by him, amounting to £463, have secured the adoption of an enlarged plan with some additions of an ornamental character in keeping with the purpose for which the building is intended.

Among the objects contemplated by the Institute, may be named the appointment of two or more members to write the history of the colonizing and progress of Canterbury, under the general direction and superintendence of the Council.

Also, the publication of a work on the Botany of the neighbourhood of Christchurch, by Mr. J. F. Armstrong, Government Gardener,—under the auspices of the Institute.

Committees have also been appointed for the collection of information upon various subjects of public interest, and from these, if re-appointed, useful reports may be expected during the course of this session.

Since the 1st of July sixteen original papers have been read before the Institute.

Numerous gifts have been received by the Institute.

Copies of the first volume of the "Transactions of the New Zealand Institute" have been received for distribution among members, and application has been made for a further supply.

In the volume of "Transactions" for next year, a selection from the papers read before this Institute, will also appear, following up those which have been given in the first volume.

It rests with the Board of Governors of the New Zealand Institute to make the selection, while it falls to the members of this Society to elect one of their members to a place at the Board.

A sum of £36 18s. 6d. has been expended in providing suitable accommodation for the members of the Institute, at their place of meeting, and also for the books and other gifts deposited there. The room of the Institute is open to members at any time. A sum of one hundred pounds sterling has been remitted to England, for the purchase of valuable scientific works of reference; a copy of the list forwarded lies open for the inspection of members, and a suggestion book has been provided in which members may inscribe the names of such additional works as they would recommend to the Council for purchase during next year.

A change has been made in the commencement and termination of the annual proceedings of the Society, in order to bring them into full agreement with those of the New Zealand Institute; and for the purpose of effecting this alteration, members will be asked to pay one guinea each as their subscription for the half-year ending December 31st of the present year. For the future the yearly accounts and proceedings of the Institute will date from the 1st of January to the 31st of December of each year.

The progress which has been made during the past year encourages the Council to hope that the Institute will become increasingly serviceable in promoting the interests of science, as a depôt, where all recorded observations of natural phenomena will be received and attended to, and where men of literary and scientific pursuits or tastes may meet for the interchange of ideas. The number and character of the papers read before the Institute may be taken as a very satisfactory evidence of the importance attached to such pursuits in a young colonial society.

Christchurch, July 8, 1869.

On the motion of Dr. Turnbull, the Honorary Secretary was directed to have the Report printed.

The Honorary Treasurer, J. W. S. Coward, L.S.A., read a statement of the receipts and expenditure during the year, which was approved of, and ordered to be printed.

Dr. Haast, F.R.S., gave a verbal description of some moa remains, and specimens of flint and stone implements, discovered in certain ovens of Moa-hunters' encampments, situated near the mouth of the Rakaia.

A lengthened discussion ensued on the probable age of these remains.

SEVENTH MEETING. *August* 4, 1869.

J. Haast, Ph.D., F.R.S., President, in the chair.

The President (Dr. Haast) read a letter from W. H. Flower, F.R.S., Curator of the Royal College of Surgeons, England, relative to contributions to the Canterbury Museum; also, letters from Professor Agassiz, on the same subject.

Papers read:—

(1.) "Sanitary Measures to be adopted for the prevention of Small Pox," by Dr. Frankish.

(2.) "On Sewage Irrigation and its results, with a sketch of the main drainage systems of London and Paris," by Selby Tancred, Assoc. Inst. C.E. (See ante, p. 214.)

EIGHTH MEETING. *September* 1, 1869.

J. Haast, Ph.D., F.R.S., President, in the chair.

Mr. W. H. Flower, F.R.S., was elected an honorary member.

The election of officers for the ensuing year was then proceeded with.

Dr. J. Haast, F.R.S., was re-elected President, and the Rev. Canon Wilson, and T. Nottidge, were elected Vice-Presidents.

J. W. S. Coward, L.S.A., was re-elected Honorary Treasurer, and the Rev. C. Fraser, M.A., F.G.S., Honorary Secretary.

The following gentlemen were chosen members of the Council:—C. Davie, E. Fereday, E. Jollie, H. J. Tancred, W. Rolleston, and S. Tancred.

On the motion of the Rev. C. Fraser, the following resolution was adopted:—"That the Council be instructed to postpone the annual dinner of the members of the Institute from the middle of September until the 8th of October next, that day being the hundredth anniversary of the landing of Captain Cook in New Zealand."

On the motion of Mr. Nottidge, it was resolved,—"That it is expedient a section should be established for the prosecution of microscopical researches, in order that members may have opportunities of meeting and working together with fewer formal restraints than are necessary at the ordinary meetings of the Institute."

On the motion of Mr. Nottidge, it was resolved,—"That the Council be requested to purchase, for the Institute, a good microscope, and such accessory apparatus as they shall deem advisable. And that for the above purpose the Council be authorised to expend a sum not exceeding forty pounds sterling."

Papers read:—

(1.) "On the Geology and Palæontology of the Waipara District," by Dr. Haast, F.R.S. The writer expressed his opinion that while the Saurian remains found in the district were undoubtedly similar to those of the late Secondary, or Cretaceous strata, in Europe, the shells and plants were as decidedly Tertiary, judging by the European standard. [Printed with Reports of Geol. Survey N. Z., 1869-70.]

A discussion followed, in which Messrs. Bowen, Nottidge, and the Rev. C. Fraser took part.

(2.) "The earth of New Zealand a bad conductor of Electricity, as compared with that of other countries," by F. E. Wright. (See ante, p. 226.)

(3.) "On the structure and colour of the fibre of *Phormium tenax*," by T. Nottidge. (See ante, p. 108.)

NINTH MEETING. *October* 6, 1869.

J. Haast, Ph.D., F.R.S., President, in the chair.

Two volumes of the "Official Catalogue of the Exhibition of 1862," presented by Mr. Enys to the Institute, were laid upon the table.

The Honorary Secretary (Rev. C. Fraser) stated that it was necessary, at this

meeting, to choose a member to take part in the election of Governors of the New Zealand Institute, in accordance with the provisions of the New Zealand Institute Act.

On the motion of Mr. Fereday, it was resolved,—"That the President (Dr. Haast) be appointed to vote in the election of Governors of the New Zealand Institute."

On the motion of Mr. Nottidge, it was resolved,—"That the Honorary Secretary be requested to write to Dr. Hector, to ascertain whether any, and if any, what provision has been made to defray the expenses of the members appointed to vote for Governors of the New Zealand Institute, and also for the expenses of Governors so appointed."

Dr. J. Haast, F.R.S., exhibited a specimen of the *Euplectella speciosa*, a sponge, sometimes called Venus's Flower Basket, which had been obtained for the Museum from Manilla.

Paper read :—

"On a proposal to divert the Stream of the Avon to a new channel along the North Town Belt, and to make the present river-bed a main drain for the town, occasionally flushed from a sluice," by J. S. Turnbull, M.D.

A discussion ensued on the practicability of this scheme, and of forming a second channel for the storm waters along the North Belt, and drains on the two sides of the river flushed by its waters.

The Rev. C. Fraser drew attention to the prediction of Lieutenant Saxby, respecting certain remarkable effects likely to be produced upon the tides in consequence of the peculiar relative positions of the sun, moon, and earth. Mr. Fraser expressed his opinion that there was no ordinary conjunction of these bodies which could have an effect upon the tides, as much greater than that produced at the spring tides as those spring tides exceeded the ordinary daily tides.

ADDRESS,

Delivered October 8th, being the anniversary of Captain Cook's first landing in New Zealand, by Julius Haast, Ph.D., F.R.S., President.

When, seven years ago, I had the honour, as first President of this Institution, to address you at your first anniversary dinner, I offered you a short *resumé* of the scientific researches and results obtained in New Zealand since the time when the colony was formed. An attempt to do so to-day for the past seven years would be a far greater, but also still more gratifying task, owing to the wonderful advancement New Zealand has made during that time in intellectual pursuits, and their results—a matter of great and sincere congratulation to the members of this Society, and to the colony at large.

When, in 1862, the Philosophical Institute of Canterbury was called into existence, there was no other Society in New Zealand which had the ambition to aspire to such high aims as we did, and although we failed in many respects to carry out our programme, we may at least safely claim the merit of having formed a depository for scientific researches in Canterbury, which did not at that time exist in any other part of New Zealand. It is true there was an older Society, with similar aims to ours, in Wellington: but for many years the members had not met, and, in consequence, some of them had their papers read before you. But how different is it to-day? Not only have scientific societies been created throughout the colony, but they have likewise found a centre in the New Zealand Institute in Wellington, the well-directed efforts of which will result in great advantages, both in an intellectual and material point of view, to the inhabitants of the land of our adoption.

The first volume of the "Transactions and Proceedings of the New Zealand Institute," embodying the labours of all the affiliated societies, which is in our hands, gives palpable proof both of the value of that body, even in the first year of its existence, and of the marked attention which has been paid to scientific matters, even amidst the absorbing occupations incidental to founding a colony. And from year to year the value of the Institute will be enhanced by its evoking in many quarters scientific research, often of great utility in promoting the advancement of the colony, which otherwise would have lain dormant, either from the want of example and encouragement, or of a proper organ for publication. Whatever may be the political tenets of those who are friends of science, literature, and art, in New Zealand, in one thing I am sure they will agree with me—that in any circumstances a centre for the maintenance of intellectual life amongst the inhabitants of New Zealand is of incalculable importance to us all, and that the creation of a depository where the results, whether small or great, of all labourers in the domain of the mind, can be collected and published, is an important step towards the advancement of this colony to that position which it deserves to occupy. These labours, after becoming at once accessible to the present inhabitants, will be preserved for coming generations, forming, as it were, the foundation stone of future research.

Viewed, however, from another point of view, the encouragement of intellectual, and in this instance I may say, physical research, will be of the highest benefit to the colony,

as it will most probably lead us to pay more attention to the study of physical science in our schools, high and low, than has hitherto been the case. Unless this be done, our colonial youths, when they come into competition with new arrivals from the Northern hemisphere, will have no chance in the struggle of life. I think the time is long since past when the education of a young man who does not intend to follow any of the so-called learned professions, should be considered finished when he has acquired some knowledge of Latin, a little less of Greek, with the rudiments of Mathematics, all of which, as soon as he enters active life, he usually tries to forget as fast as possible, owing to his having, as a general rule, by always being overworked, been bored to death by them. But the things he ought to have learnt, which he would treasure in his mind, which would give him intellectual enjoyment and invest him with great advantages, both intellectual and practical over those who had not followed the same course of study, he has never been taught, and any allusions made to them have often been of a disparaging character.

The Universe, the sublime laws by which the innumerable suns, planets, and their satellites around him are governed; the earth, which is his home, with all its wonderful treasures, animate and inanimate, and their relations to each other, are totally unknown to him. He wanders, as it were, blindfolded over this beautiful earth, a stranger in his own domain—Heaven and Earth a sealed book to him. And is it possible that any other study, however sublime, can be compared with that of the works of God, which certainly must elevate the mind far higher than that of the works of men, however excellent they may be? But, in order that I may not be misunderstood, I wish to assure you that I should be very sorry indeed to see classical languages and Mathematics removed from the curriculum of our schools. Such a proceeding would also be suicidal to the aims of Physical Science. The study of any language, whether ancient or modern, and of its best authors, will always enlarge and elevate the mind, exercise the memory, and evoke or cherish noble feelings and actions in the learner, whilst the study of Mathematics will teach him to think logically and accurately, without which, Physical Science would be above his comprehension.

The acquisitions of the natural philosopher, of the astronomer, of the chemist, or of the geologist, obtained by actual research or by induction, can only be considered of lasting value if they have been corroborated or proved by strictly mathematical reasoning, in having, as it were, been reduced to mathematical formulæ. But here, again, I may once more point out that only those young men will reap the full benefit of the wisdom of the ancients and of mathematical investigations who intend to continue their philological and mathematical studies, while those who, after leaving school, enter into a walk of life in which such knowledge is not required, will shortly have forgotten all that was drummed into them during a number of years, and, at the same time, will have cause to regret at every step they take, both their ignorance of Physical Science, and their want of acquaintance with the laws and treasures of nature around them.

The question naturally arises, why, since Physical Science has made such wonderful strides during the last three centuries, that mankind has advanced more during that time than in any similar period before in the history of the world, the education of youth, even of the higher classes, has been almost stationary; so that we can truly say it still resembles in many respects the course of teaching in those times when the native language of the country was despised as unworthy of being taught; when old women were burnt as witches; when the stars in the firmament were only thought to be placed in the heavens to form constellations by which the life or fate of man was guided; when chemistry was alchemy, and its chief use considered to be the making of gold from baser metals, or the brewing of the Elixir of Life; and when the little knowledge of Physical Science (Natural History included) possessed in these days was mixed up with superstition and scholastic axioms? The answer to this question seems to me to be very simple. The only exact knowledge possessed at that time was Mathematics, principally their higher branches, together with the philosophical, poetical, and prose writings of the eminent men who had shed a bright lustre over the periods in which they lived. These writings were the precious heirloom which antiquity had bequeathed to the middle ages.

As such learning was then considered to be the only kind of knowledge worth possessing, all intellectual energy was directed to its acquisition, and the professors of the day despised the ignorance and superstition of those to whom the treasures of antiquity were not accessible. They also, and naturally, showed contempt for alchemists, astrologers, and others pursuing knowledge in a similar manner, and while unable to refute the latter, their mathematical knowledge made them feel that the doctrines of those men were erroneous. A remnant of this feeling of contempt for the study of physical science still lingers in some countries amongst the teachers of the so-called classical schools; although they do not like to confess it even to themselves; and being desirous of continuing the teaching of their predecessors, they consider it as the invasion of an upstart into the holy precincts of their educational temple when physical science wishes to enter the schoolroom. Unfortunately, many of these teachers, however eminent in other respects, know very

little of physical science, and this may be an additional reason why they resist its introduction into the curriculum, since they are not able to understand its value; while it must also be allowed that they have just cause to look with pride upon many distinguished men who, educated at their schools, have without such knowledge, brought great credit to those institutions. Here human nature simply comes into play.

On the Continent of Europe and the United States, this defect has already been partially remedied, and in Great Britain powerful advocates, even from the ranks of the most eminent classical scholars, have come forth to break their lances for the introduction of such studies into all schools. In your mother country they are mostly men who have travelled, who have seen the advantages conferred by such studies upon a whole generation in other countries. They have witnessed the delight of the pupils when, after the study of languages and mathematics, natural history, geology, mineralogy, and chemistry, had their turn, and refreshed the scholars for the drier work. They have seen what a treasure the pupils carry with them when they leave school by possessing some knowledge of the laws by which the Universe, from our central sun down to the smallest atom upon earth, is governed, and experiencing that delight which a contemplation of Nature affords—how it ennobles their daily occupation, fills their leisure hours, and teaches them to observe and think. But what intellectual resources of this kind has a young man who leaves a school conducted on our present system? Is he not nearly as much a stranger on this beautiful earth as when he first came upon it, and where will he find time, amid the turmoil of life, to gain that knowledge so necessary to him now-a-days, but which, during the many years of his school-life, was withheld?

I trust you will not think I am overstepping my privileges in thus openly expressing my opinion about the present mode of teaching the rising generation, but I should neither be doing my duty, nor deserve the honourable position in which you have placed me, did I not state fearlessly, and without restraint, my convictions on the subject. But, I repeat, that should not some attention be soon paid in our schools to the study of physical science, the time is not distant when in the race of life and in competition with young men from other countries, our colonial youth will be left far behind. However, I have no doubt that many years will not elapse before the people of Great Britain which, of all nations, has the most practical national sense, will thoroughly remedy the evil, and that there will be no country on the face of the earth where the study of physical science is more fostered, so as to preserve to that empire its pre-eminence in the great race of nations, in which, after all, the arts of peace, civilization, and industry will give the ultimate decision. I have detained you too long upon a subject, which, during the last few years, has been treated by such able and distinguished men, that perhaps I could have left it in their hands had I not thought it my duty to allude to it.

In order to honour more fully the memory of that illustrious navigator who was the real discoverer of New Zealand, we have fixed the day of our anniversary dinner upon the day when, one hundred years ago, Captain Cook landed officially in New Zealand, and it is from that day that the blessings of civilization have been bestowed upon these beautiful islands. Captain Cook was forty-one years old when he reached our coasts, he being born on the 27th August, 1728. He was in every respect a son of the people, having raised himself from the ranks by his knowledge, honesty of purpose, and courage—one of the most remarkable men which the eighteenth century produced. He not only advanced far into the Arctic, but also explored three times the Antarctic zone, which had never been visited before. It is from him that we not only obtain the earliest reliable accounts of most of the islands of the Pacific Ocean, of the north-west coast of America, of Behring's Straits, and of the Antarctic regions; but he also fixed astronomically, innumerable points on the coasts visited by him, generally with such admirable accuracy, that we still look upon them as reliable authorities. His accounts of the geographical features of the countries visited by him, and of the manners and customs of their inhabitants are also among the most reliable and valuable we possess. He died in the cause of science—an irreparable loss not only to his country, but to the world at large. Truly he may claim to be called the Columbus of the Pacific Ocean, and the inhabitants of the Australian Colonies and New Zealand owe him a great debt of gratitude, because it was his foresight, and his excellent judgment of the natural capabilities of the countries visited, which principally directed the attention of the statesmen of the mother country to these distant lands, where now a branch of the Anglo-Saxon race is occupied in laying the foundations of an empire which, in centuries not far distant from our own, will be ranked amongst the first of the earth.

Although every intelligent inhabitant of this country honours the name of Captain Cook, would it not be possible to show this by another mark of our respect? and I therefore do not hesitate to offer a suggestion which I hope will be taken up and acted upon by our legislators. Hitherto great confusion has prevailed relative to the name of this island, which is called both the Middle and South Island. The appellation Middle Island is a mistake, as the size of Stewart's Island precludes it from being ranked with the two others. The most eminent geographers of Great Britain and of the Continent of

Europe—such men as Arrowsmith, Keith Johnston, Petermann, Hochstetter, etc.—call it always the South Island, while in New Zealand, even in official documents, it is called sometimes by the one, sometimes by the other name. In order to avoid further misunderstanding, would it not be appropriate to give this island the name of Cookland? for, so far as I am aware, no country visited by that illustrious navigator has been so designated; or in the case of the Northern Island claiming that name, on the ground of it being the first part of the country where Captain Cook landed, might not another distinct name be given to it, D'Urville Land, Antipodea, and Alexandra Land, having already been proposed. I should have suggested its being called Tasman Land, had not the inhabitants of Tasmania rightly appropriated the name to their island. However, I am quite content to have mooted the subject, and leave it in the hands of our legislators to move in the matter, which, as I believe, deserves some consideration at their hands.

I have to congratulate you upon the near completion of the new museum building, where it will be possible to find the necessary room for the proper arrangement of the collections belonging to the province, and to which the public has so liberally contributed, and I am proud to say that our Institute may claim some little credit in the work of bringing about this desirable result, it having for several years urged the erection of a proper building upon the Provincial Government, and those of our members who also hold seats in the Provincial Council having likewise laboured in the same direction.

The report of your Council, laid before you on the 8th of July in this year, justly points out that we all have cause to be satisfied with the advance made by the Society during the past year with the accession of new members, and its general prospects in the future. Our principal aim being to promote the intellectual and material progress of Canterbury, a great deal still remains to be done towards accomplishing so desirable an object. At the same time, I may claim the sympathy and assistance of the inhabitants of the province for our Society, which can only progress when the province at large takes an interest in our doings and augments our ranks, so that we may gain more workers in the common field of enquiry. Will you here allow me to offer you my warmest and most sincere thanks for the honour you have done me in again electing me your President, and will you kindly receive my promise that I will endeavour to do my duty to the Society to the best of my ability. I desire, however, to express a hope that you will allow me to retire at the next election into your ranks, giving place to some other member, who will be able to conduct the business of the Philosophical Institute more efficiently than I have done.

Although much has been discovered, and wonderful inventions have been made, a great deal of the general field of enquiry still remains unexplored; not to speak of the peculiar rewards which New Zealand offers to the student and lover of nature. Let us, therefore, strive to contribute our share towards the accumulation of those facts, by inductive reasoning on which sound knowledge can only be gained, and however small the mite which we may be able to add, it will always be some addition towards the great mental edifice raised by the intellect of mankind to the glory of that First Intelligent Cause, in Whom all ultimate knowledge rests, Whom we vainly seek to conceive or to understand, and "in Whom we live, and move, and have our being."

TENTH MEETING. *November* 3, 1869.

J. Haast, Ph.D., F.R.S., President, in the chair.

The Honorary Secretary (Rev. C. Fraser) intimated that he had written to Dr. Hector respecting the expenses of delegates for electing Governors, etc., but had as yet* received no reply. He understood, however, that it would be necessary for the delegates to proceed to Wellington in order to take part in the election.

Mr. G. W. Hall moved,—"That a committee be appointed to obtain information as to the various grasses, native and artificial, suitable for stock feeding, and especially as to the best means of utilising the grasses indigenous to the colony."

The motion was seconded by Mr. Fereday, and carried, after some discussion on the result of experiments which have already been made, the necessity of extensive correspondence, and a liberal allowance of time to the Committee for bringing up their report.

The Hon. J. B. Acland, Messrs. J. Hall, R. Wilkin, J. F. Armstrong, A. Duncan, and the Mover, were appointed a Committee to carry out Mr. Hall's resolutions, and power was given them to add to their number.

Mr. Nottidge moved,—"That a Committee be appointed to draw up a code of rules for the Philosophical Institute of Canterbury; such Committee to consist of the Rev. J. Wilson, Mr. R. Fereday, and the Mover."

The motion was carried, on the understanding that the new code would be merely a simplification of the present rules.

* Letter received on November 1st; answered on 2nd.—J. H.

Paper read :—

"On the Tendency of Modern English Poetry," by W. C. Purnell.

Dr. Haast read letters from Mr. Townsend, of Akaroa, and Captain Gibson, Harbour Master at Lyttelton, on the subject of the tidal disturbances expected to occur on October 5th. The former stated that on the day in question the water in Akaroa Harbour was lower than it had been since the great earthquake wave of August, 1868; that six tides in succession were unusually low; and suggested that the sun and moon being both on the equator at the time, an accumulation of waters would take place there, and consequently a lowering of the level in this part of the world. Captain Gibson stated that he had taken measures for ascertaining the precise extent of any tidal disturbances which might occur at Lyttelton, but nothing unusual happened.

A short discussion followed on the reading of the letters.

OTAGO INSTITUTE.

SESSION OF 1869.

PROCEEDINGS.

First Meeting. *July* 20, 1869.

Mr. Justice Ward in the chair.

A Constitution and Rules for the Institute were adopted.

Office-bearers for the year ending 30th June, 1870, were elected, viz. :—*President*—His Honor Mr. Justice Ward; *Vice Presidents*—Alfred Eccles, F.R.C.S.E., Arthur Beverley; *Council*—L. O'Beal, Captain Fraser, R. Gillies, S. Hawthorne, Rev. D. M. Stuart, J. Smith, J. T. Thomson; *Honorary Treasurer*—W. D. Murison; *Honorary Secretary*—J. S. Webb.

Second Meeting. *August* 24, 1869.

Mr. Justice Ward, President, in the chair.

The Chairman, as President of the Institute, delivered the following

INAUGURAL ADDRESS.

I desire to render all suitable acknowledgments for the honour you have done me, in electing me the first President of the Otago Institute:—an honour most unwillingly accepted, knowing as I do how many of those present are far more competent than I, to fill so onerous a post, and have far more leisure to devote to its duties. But I fully admit that every community has a right to call on those who hold high office in it, to take their share in such a movement as the present, and however inefficient my services may be they will at least be zealously given. I need scarcely say, also, that I am well aware, that in this instance, as in many others, the honour is rendered rather to the office than to him who happens for the present to fill it.

We have met to-night to inaugurate a Society for the encouragement of Art, Science, Literature, and Philosophy. It would be difficult to lay wider foundations; and it is encouraging to reflect that, although Otago has not taken the lead in the formation of an Institute, such as the present, yet, in other respects, she may fairly claim precedence. No other province has attempted what Otago performed in 1865, at the Intercolonial Exhibition. Scarcely an effort has been made elsewhere to carry out such a Fine Arts Exhibition, as that which took place this year at Dunedin, none have been equally successful. With such successes in the past we may well look forward with confidence to the future. In so young a colony as ours, it is in the power of every man of average ability to leave behind him some "footprints on the sands of time," pointing in the onward direction; and if the inhabitants of Dunedin only continue to display, in the cultivation of Arts and Science, one tithe of the energy that has hitherto distinguished them in mercantile and professional pursuits, we need have no fear of our ultimate success.

As the Otago Institute is now fairly launched, the first question for us to determine is, whether we are to stand alone, or to be incorporated with the New Zealand Institute. The principal advantages of incorporation, shown by the Act of 1867 (by which the New Zealand Institute was created), are, that we shall obtain, 1st, the invaluable services of Dr. Hector, in superintending any Museum or Laboratory that we may hereafter possess, or which may be entrusted to us; and 2nd, a share of any sum that may be placed on the Colonial estimates for the purposes and expenses of the New Zealand Institute. But the greatest advantage of all lies in the fact, that, in all such societies as the present, co-operation is the highest requisite for success. In all probability the most useful work that at this moment lies before the New Zealand Institute is the compilation of a complete Natural History of the colony; and to that history the Institute of each province should contribute a chapter. Without the co-operation of all, to attempt such a work would be hopeless.

If, however, we prefer independence, the path is open; and whichever we determine upon, I trust we shall legally unite in carrying out our present undertaking, so far as our ability extends; I trust, too, that we shall be guided in our pursuit by the precepts of that philosophy, which has been mentioned as one of the special objects we hope to promote. I do not allude to the visionary theories set forth by the magnificent eloquence of Plato; nor to the barren sophistry of Scholiasts, into which degenerated the more practical codes of Aristotle. Still less should we follow the school of the eighteenth century, though their pages be illumined by the massive and splendid diction of Gibbon, the lucid beauty of the style of Hume, the brilliant imagination of Rousseau, and the scathing sarcasm of Voltaire. Their philosophy commenced by a denial of the truth of Christianity, and appropriately culminated amid the orgies of the French revolution, in the blasphemous worship of the Goddess of Reason. Their anti-christian writings have already passed into deep shadow, soon to darken into night. There are records of their powers of distraction, but of their philosophical creations scarce a trace remains. On the other hand, the philosophy of Plato and Aristotle, though favoured by Emperors, fostered by the Church, after a culture of two thousand years, ended where it began, in words, and words alone. Let us turn rather to our own great countryman;—to him who wrote, at the age of thirty-one, that he had "taken all knowledge to be his province," and whose right to assert this has never been questioned. It was reserved for Francis Bacon to show that the highest end of wisdom is to be of use; and that nothing that is of use to the meanest, is below the notice of the highest. The ancient philosophy aimed at training men to endure evils patiently; that of Bacon preferred to remedy them. Plato deemed the most brilliant invention in mechanics, a discredit to a true disciple. Bacon estimated a philosopher's learning solely by the fruit it promised for the use of man, the "Novum organum," Bacon's greatest work, gave a new direction to the human intellect; and by that change, has changed the face of the world.

To apply his precepts to our present object, we should constantly keep in mind that there is not a rock on the mountain, a stratum of soil in the plain, a tree in the forest, or a herb in the pasture that has not its use—what that use is, it is for science and experience to discover; and every new discovery adds a new source of wealth to the colony, and a fresh incentive to immigration. And it is in bringing together for the test of science the results of experiences scattered through the colony, that the value of co-operation amongst the Institutes of the various provinces, will be especially manifested.

Take, for instance, that which, next to gold and coal, is probably our most important indigenous product, the New Zealand flax. The value has long been recognised, but our attempts at preparing it for export have been simply a series of blundering experiments. Let each Institute prepare a careful report on the varieties of the plant, the modes of culture, the chemical and mechanical means used in preparing it for use or sale; and forward with that report models of the machinery used, and specimens of flax in various stages of preparation. Let the whole of these reports, models, and specimens be laid before some able chemists and mechanicians; before men who are not only thoroughly versed in those sciences, but who have all the appliances of science, and ample time to use them. Our experimental difficulties would soon be solved; and it would be difficult to over-estimate the importance of their solution to the colony. Within a few years after, the export of flax would probably rival in importance that of wool.

With respect to scientific appliances, we may congratulate ourselves on the fact that the province already possesses a large and valuable Museum, the care of which will probably be entrusted to us by the Government. We hope to establish a scientific library, as the next requisite; and at as early a date as our funds permit, to add a laboratory. We trust to be in close connection with those Acclimatisation, Agricultural, and Horticultural Societies, which have already conferred so much benefit on Otago. In every town, and in every gold field we should have our correspondents, and every change in the face of the province, every new botanical or geological discovery, every rare phenomenon of nature, should be registered on our records. The contribution of original papers, with lectures and periodical meetings, complete all that we can expect to compass for the

present; hereafter it may be that, in connection with this Institute, schools of chemistry, painting, and sculpture may be established; that our successors may offer prizes for essays and poems; may form a provincial gallery of pictures, and establish a yearly Fine Arts Exhibition, such as that which afforded both pleasure and instruction to the public of Dunedin in the present year; but the day for these has not yet come, and for the present we must attempt no more than our strength will warrant.

There is one subject which has recently been much discussed among us, and on which, therefore, a few remarks may not be out of place: I allude to that which is termed by its votaries the "new faith of Spiritualism." No creed, which numbers its believers of the Anglo-Saxon race by tens of thousands, can be beneath the attention of the wisest of modern philosophers. In fact, there are few psychological phenomena of our time which call for keener investigation from men of science than those attributed to spiritualism. Of those who believe in them, one-half, unable to explain or account for them, accept, without hesitation or enquiry, the theory propounded by their exhibitor; of the rest, the greater number attribute them to the direct agency of Satan. And by philosophers they are, for the most part, too hastily dismissed, as purely the products of jugglery and imposture. We would do well to remember that Lord Bacon, at the close of his treatise on Natural History, when referring to magic, and the powers of imagination, earnestly recommends that "whatsoever is of this kind should be diligently inquired into." These phenomena were in secret to the magicians of Egypt, to the astrologers of Babylon, or the priests of the oracles of Delphi. In all ages they have existed, in all ages they have been connected with religious belief. In Europe, their existence faded away with heathenism, before the pure light of Christianity. But in the recesses of the East there have doubtless always lingered some relics of the mysteries of the ancient seers of Chaldea. Two of the most observant of modern travellers, Hoe and Gabi, declared their inability to account for the marvels they witnessed amid the demon worship of Thibet, save by referring them to the interposition of evil spirits. In the European revival of these practices, the principal novelty consists in their assumed connection with Christianity. Of old, these secrets were jealously guarded by those who profited by their possession; but whatever is of Christianity should bear the strictest scrutiny in the clear light of day. Doubtless, in the vast majority of cases, the phenomena are produced by causes, of the rationale of which the operators themselves are wholly ignorant; and in such cases mediums and querists are duped alike. When there arises a philosopher who will not pretend to despise these phenomena for fear of injuring his reputation for good sense—a man of science, unswayed by imagination or superstition, who will apply to them the test of Faraday and Liebig—we may then hope to learn by what cause, and in what manner, are produced the marvels, real or pretended, to which spiritualism owes its present celebrity. No enquirer of the present day should be awed by the word, or the theory of the supernatural, what the laws of nature are we may know when we stand face to face with Him by whom those laws were given. Until then, "We see through a glass darkly;" until then, we shall do well to remember that mysteries are not necessarily miracles; that marvellous phenomena are not necessarily supernatural, because we know not by what law of nature they are produced or governed.

I have now pointed out—how imperfectly none know better than myself—some few of the objects we may strive to obtain, and the directions in which our efforts should tend. Doubtless, our part will be rather that of Moses than of Joshua—we may lead others to the borders of the promised land, which we may not live to enter ourselves. But when we have done our best we shall have done our duty to our successors. It is true, that amid all our daily toils we are but "Stumbling with our weight of cares upon the world's great altar stairs, that lead through darkness up to God." Yet let us remember that it is written, "Whatsoever thy hand findeth to do, do it with all thy might." If we have planted, others will water, and God will give the increase, as seems best to Him: and when that day comes that even now is faintly dawning, whose meridian splendour will shine over the next generation of colonists—when the name of New Zealand is written on the roll of nations, and she takes her stand as a member of that great Anglo-Saxon federation which will then sway the destinies of half the world, we may hope that it will then be acknowledged, that through the busy toils and arduous struggles of early colonization, the New Zealand Institute and her sister Societies held aloft the torch of science and fed the lamp of literature; and that among the foremost in that race of honour, upon which we have now entered, will be the Society which we inaugurate to-night—the Institute of the Province of Otago.

On the motion of Mr. A. Eccles, seconded by Mr. R. B. Martin, an unanimous vote of thanks was accorded to the President for his interesting address.

THIRD MEETING. *September* 24, 1869.

A. Eccles, F.R.C.S.E., Vice-President, in the chair.

The Honorary Secretary laid on the table several donations to the Library.

Moved by Mr. J. S. Webb, seconded by Mr. R. Oliver,—"That the Council request the Governors of the New Zealand Institute to take the necessary steps for the incorporation of this Society with the Institute."

Moved, as an amendment, by Mr. Robt. Stout, seconded by Mr. J. Logan,—"That the debate be adjourned, with the view of affording the Secretary an opportunity of obtaining from each member an expression of opinion, in writing, regarding the proposal for incorporation."

The amendment was put and lost, and the motion was carried *nem. con.*

FOURTH (SPECIAL) MEETING. *October* 30, 1869.

A. Eccles, F.R.C.S.E., Vice-President, in the chair.

The Honorary Secretary stated that the meeting was called for the purpose of appointing a member of the Institute to vote at the election of Governors of the New Zealand Institute, in accordance with clause 7 of the "New Zealand Institute Act, 1867."

Mr. J. S. Webb (Honorary Secretary) moved, Mr. W. M. Hodgkins seconded,—"That Mr. Justice Ward be appointed to represent this Institute at the election of three Governors of the New Zealand Institute for the ensuing year."

Mr. Charles Smith moved, as an amendment, Mr. G. Bell seconded,—"That this Institute declines to appoint one of its members to vote at the ensuing election of three Governors of the New Zealand Institute, until the Act of Incorporation had been so far amended, as to afford to incorporated societies real and adequate representation in the governing body."

The amendment was put and lost, and the original motion was then carried unanimously.

On the motion of Mr. J. S. Webb, seconded by Mr. C. J. Smith, it was resolved,—"That Mr. Ward, if elected to be a Governor, be requested to represent the inadequacy of the representation of local societies in the Board of Governors."

FIFTH MEETING. *November* 2, 1869.

A. Eccles, F.R.C.S.E., Vice-President, in the chair, who delivered the following

ADDRESS.

Notwithstanding all the efforts that have hitherto been made in New Zealand, in which Otago, with her topographical and geological surveys, her associations and exhibitions of all kinds, and her Museum, has not been the least conspicuous worker amongst the provinces, the colony has remained little known to others, and the best informed, even amongst ourselves, are but slightly acquainted with the industrial future before her. Yet it was said by Count Cavour, the regenerator of United Italy, that the most urgent necessity of a nation determined to take her proper place in the scale of civilization, is to study and know herself, and to point out to others her present position, and the various natural resources at her disposal.

Perhaps the most useful and practical end, then, which the Otago, as a Provincial, and the New Zealand as a Colonial Institute, can pursue, is to strive to obtain and promulgate a knowledge of the raw materials that may be found, or economically produced here, and the best means to utilise them.

A century has just elapsed since Captain Cook, accompanied by Sir Joseph Banks and Dr. Solander, first landed in these islands, and much that has been subsequently recorded by scientific observers (especially in the field of botany), has been but confirmatory of their observations. Yet should we, who are benefitting so largely by their labours, give great honour to those practical men of our own day, who first founded settlements on these shores, of which they may well now be so proud; to those scientific men whose labours have done so much towards obtaining and classifying such information concerning the resources of the colony as we possess; and to those fortunate discoverers and producers who have, through gold mining, agriculture, and other industries, added so much to our wealth. When we look around us and remember, that even this settlement was literally a wilderness only twenty-one years since, we may well say that very much has been done, and we may rest assured that, whether assisted or not by this or kindred societies, those who have accomplished so much, and still remain amongst us,

will not cease from their labours; nor will their children, or new-comers fail to do their utmost, while pushing their own fortunes, to aid in advancing the general prosperity of the province and the colony.

Recognising all this, how much has been, how much remains to be done, it is certain that the time has arrived to facilitate individual labour by the *systematic* collection of information as to what has been accomplished, and pointing out the various directions in which research or discovery would be most desirable, and most probably prove beneficial to individual workers and the community at large. Here will be a great and almost virgin field for the members of this Institute—to collect a really good library of works of reference, a want that is continually being felt, notwithstanding that many useful works are already to be found scattered amongst local libraries—to render more perfect that Museum, which it is but scant justice to Dr. Hector to say, forms a splendid nucleus for future additions—to collect and record fully and accurately facts of all kinds that relate to our industrial development, even though at the moment we may not be able to foresee their exact value or true bearing—to prepare practical papers, however short, and it may be not altogether conclusive, to be elaborated by careful discussion at our meetings, and to collect for the New Zealand Institute, and other such societies elsewhere, not only museum, but trade specimens of our products, whether raw or manufactured, with full and accurate information concerning them.

The Royal Colonial Society, lately established in London, offers us great facilities for the exhibition of our products in its Museum, and of maps, statistics, and records in its Library, access to which will be so easy to those at home seeking information of any kind as to the colony. No one who has himself encountered the difficulty of obtaining reliable information on colonial subjects in Great Britain, or has observed, since he has himself become acquainted with the colonies, the lamentable ignorance displayed by even leading statesmen, affecting to govern them from Downing Street, will lightly estimate the valuable services colonists and the Colonial Society may mutually afford each other, and offer to enquirers, whether commercial, scientific, or public men at home. It would be well then for a sub-committee of this Institute to be appointed to make collections, representative of Otago and her resources, both for the Museum and the Library of the Colonial Society. So good an example would be speedily followed by other societies incorporated with the New Zealand Institute, and, after awhile, their united efforts would result in a collection eminently useful to New Zealand interests in Great Britain. We may be sure, too, that other colonies will avail themselves of the organisation afforded by the Colonial Society. Let us hope that there will soon be in that society's rooms a museum and library worthy of the Colonial Empire, not only rivalling, but surpassing the fine collection of Indian products and manufactures constituting the Indian Museum in Whitehall. Let it not be said that the bureaucratic government of India is more practically useful than the freer institutions of the colonies; or that self-government is but another name for slow material-development. Let colonists show to others what they know themselves of the enormous extent and value of the resources of the colonies, and then we may be sure the political value of these great countries will not, as now, be either doubted or ignored.

It would be necessary for the sub-committee to transmit with the specimens, etc., full and precise information as to the products themselves, their situation, extent, cost, transit, and other incidental charges, without which they would be mere curiosities, and of little value economically; and, in return for these contributions, we may fairly expect to receive from the colonial and other societies to which they may be sent, copies of their own publications, specimens of similar products obtained elsewhere to compare with ours, samples of manufactures from them, and such reports on the commercial and scientific value of the New Zealand specimens, as would be extremely useful to us as their producers.

We are, fortunately, able to obtain from the Director of the Geological Survey of New Zealand, very valuable information on the mineralogical and chemical characters of the ores, etc., etc., submitted to him; but frequently it is desirable to get accurate information as to the commercial value of products, and how far they can be made to pay; to obtain which, it is almost absolutely necessary, that they should be submitted for examination and report to those trade experts, who are seldom found except in the great marts of the world.

Scattered as is the population of the province, might not we, enlarging on the suggestion of our President in his eloquent inaugural address, establish branch or corresponding societies in some of the country towns? In these branch societies, would probably be prepared and read, papers of a peculiarly practical bearing, on subjects specially interesting in each particular locality, and which would be the more valuable from being discussed on the spot by men possessing the advantages of local knowledge, and minute practical acquaintance with their subjects. I could almost wish, too, that the efforts at present scattered amongst so many public bodies in this province, such as the Agricultural and Pastoral, the Acclimatisation, and the Horticultural Societies, the Committees of the

Museum, and certain public Libraries, and the superintendence of the Botanic Garden, etc., were focussed under the auspices of this Institute, either by association or otherwise. Whatever good the present generally desultory, and often antagonistic efforts, may have produced, a more perfect organisation, oneness of direction, and union of forces, would accomplish vastly more ; would add greatly to the usefulness and interest of each and all of the sections, which collectively would then constitute the Otago Institute ; and would lead to much more economical working, much greater results, and build up such an institution as would prove of great worth, both to the province and the colony.

Mr. Webb with the view of supporting remarks contained in the address by Mr. Eccles regarding the products of the colony, mentioned that native flax was most inadequately represented in the Otago Museum. There were a number of specimens, but they were not described, nor was there anything to instruct people as to the modes of preparation, or regarding the different characters of flax. The question they had to consider was not what could be done here, but comparisons should also be instituted with what could be accomplished elsewhere.

Mr. Robert Gillies desired to make a few remarks respecting the Colonial Laboratory. It was, he believed, not generally known that any specimens, not only of minerals, but also of soils, if sent there, were analysed free of charge. When travelling in the province the question had been asked what, if any, charge was made, for analyses ; and therefore it was desirable that the fact he had mentioned should be widely ventilated. Farmers, for instance, could get specimens of their soils analysed. Referring to some remarks made by the Chairman as to an amalgamation of societies, he might mention that the President of the Acclimatisation Society, Mr. W. D. Murison, dealt with the same subject in an address which he delivered at a recent meeting of the Acclimatisation Society. Under the circumstances, therefore, he thought there would be no great difficulty in bringing about an amalgamation of the Acclimatisation and other societies with this branch of the New Zealand Institute, and that steps should be taken in that direction.

Mr. Robert Gillies read a paper on "Te Puia, a hot spring near the Wangape Lake, in the Waikato District." (See ante, p. 169.)

Mr. Webb, referring to the remark of Mr. Gillies that "Te Puia" served as a barometer to the natives of the neighbourhood, explained the meteorological principles which accounted for this fact.

Mr. Henry Skey asked Mr. Gillies as to the sulphurous odours felt on approaching the spring. The water, as analysed (see "Trans. N. Z. Inst.," Vol. i., p. 71) showed no trace of sulphur.

Mr. Gillies said there could be no doubt as to the character of the exhalations met with in the bush on approaching the spring, and suggested that they might arise from sources not directly connected with the spring.

With regard to the name "Te Puia," Mr. J. N. Watt, on being appealed to as a Maori scholar, expressed his belief that it was simply the ordinary native name for any hot spring.

In consequence of the lateness of the hour, the reading of a paper "On the Natural History Department of the Otago Museum," being the first of a series by Mr. J. S. Webb, was deferred. In place of it

Mr. Webb read a paper "On the Mechanical Principles involved in the Sailing Flight of the Albatros," being a criticism upon Captain Hutton's papers on the same subject published in the "Trans. N. Z. Institute," Vol. i., p. 58, and the "Philosophical Magazine" for August, 1869. (See ante, p. 233.)

It was resolved that in future the meetings of the Institute should be fixed for the second Tuesday in the months of September, November, January, March, and May.

APPENDIX.

THE CLIMATE OF NEW ZEALAND.

METEOROLOGICAL STATISTICS.

THE following Tables, etc., are published in anticipation of the Report of the Inspector of Meteorological Stations, for 1869 :—

TABLE I.—TEMPERATURE of the AIR, in shade, recorded at the Chief Towns in the NORTH and SOUTH ISLANDS of NEW ZEALAND, for the year 1869.

Place.	Mean Annual Temp.	Mean Temp. for (SPRING) Sept., Oct., Nov.	Mean Temp. for (SUMMER) Dec., Jan., Feb.	Mean Temp. for (AUTUMN) Mar., Apl., May.	Mean Temp. for (WINTER) June, July, Aug.	Mean daily range of Temp. for year.	Extreme range of Temp. for year.
NORTH ISLAND.	Degrees.	Degrees.	Degrees.	Degrees.	Degrees.	Degrees.	Degrees.
Mongonui . .	60·6	58·1	67·0	62·4	54·8	14·2	45·5
Auckland . .	58·6	57·0	65·7	60·5	51·6	13·8	44·8
Taranaki . .	57·3	55·4	65·5	57·5	50·6	15·2	51·0
Wellington .	55·4	54·7	62·6	56·1	48·1	12·2	49·5
Means, &c., for North Island	57·9	56·3	65·2	59·1	51·2	13·8	51·0
SOUTH ISLAND.							
Nelson . . .	55·2	54·9	64·4	55·2	46·4	20·8	57·0
Christchurch .	52·7	53·1	61·7	52·9	43·2	16·1	65·3
Hokitika . .	52·9	52·6	60·8	52·5	45·9	13·3	46·9
Dunedin . .	50·8	51·4	57·6	50·4	43·7	13·6	46·0
Southland . .	50·9	50·8	59·8	49·4	43·8	18·5	63·0
Means, &c., for South Island	52·5	52·5	60·8	52·0	44·6	16·4	65·3
	57·9	56·3	65·2	59·1	51·2	13·8	51·0
	52·5	52·5	60·8	52·0	44·6	16·4	65·3
Means, &c. for Nth. and Sth. Islands	55·2	54·4	63·0	55·5	47·9	15·1	65·3

TABLE II.—BAROMETRICAL OBSERVATIONS,—RAIN-FALL, etc., recorded for the year 1869.

Place.	Mean Barometer reading for year.	Range of Barometer for year.	Mean Elastic Force of Vapour for year.	Mean Degree of Moisture for year.	Total Rain Fall.	Mean Amount of Cloud.
NORTH ISLAND.	Inches.	Inches.	Inches.	Sat.-100.	Inches.	0 to 10.
Mongonui .	30·000	1·496	·429	80	48·340	5·6
Auckland .	29·985	1·358	·405	81	52·797	5·3
Taranaki .	29·937	1·877	·349	72	55·125	6·3
Wellington .	29·963	1·245	·344	77	56·768	5·2
Means for Nth. Island .	29·971	1·494	·382	77	53·257	5·6
SOUTH ISLAND.						
Nelson . .	29·881	1·364	·339	76	65·230	5·3
Christchurch	29·910	1·376	·323	79	27·292	5·3
Bealey* . .	29·760	1·132	...	...	85·875	4·7
Hokitika .	29·954	1·403	·348	85	88·210	6·4
Dunedin .	29·928	1·435	·281	75	32·918	5·6
Southland .	29·843	1·449	·304	80	42·680	5·3
Means for Sth. Island .	29·879	1·359	·319	79	57·034	5·4
	29·971	1·494	·382	77	53·257	5·6
	29·879	1·359	·319	79	57·034	5·4
Means for Nth. & Sth. Islands	29·925	1·426	·350	78	55·145	5·5

* 2,104 feet above sea level.

TABLE III.—WIND for 1869,—Force and Direction.

Place.	Average Daily Velocity, in miles.	Number of days it blew from each point.								
		N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.
NORTH ISLAND.										
Mongonui.	183	17	45	29	29	19	92	26	49	59
Auckland	326	35	58	34	16	66	70	43	24	19
Taranaki .	245	31	45	23	83	8	66	49	29	31
Wellington	193	16	30	1	126	0	3	0	189	0
SOUTH ISLAND.										
Nelson .	129	46	63	3	56	11	77	26	83	0
Christchurch	146	4	48	113	16	9	127	14	23	11
Bealey .	90	0	39	1	23	2	32	0	177	91
Hokitika	186	22	65	35	102	1	46	15	71	8
Dunedin .	128	27	44	18	14	27	41	87	15	92
Southland	180	36	3	26	92	3	5	93	107	0

Average daily horizontal movement, in the North Island (four stations), 236 miles.
" " " " " South Island (six stations), 143 "
" " " " " New Zealand . . 189·5 "

TABLE IV.—EARTHQUAKES in NEW ZEALAND, in 1869, as registered at the Government Meteorological Stations.

Station.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November	December.	TOTAL.
Auckland .	...	...	...	...	...	...	...	...	...	...	...	...	0
Napier .	...	11, 27	...	...	...	...	...	...	...	...	...	...	2
Taranaki .	10	22, 23*	4, 10, 15	20	...	...	16*	...	...	...	...	...	8
Wellington	9	11	...	...	...	1*, 5	4	4*, 26	30	...	...	...	8
Nelson .	...	11*	13*	...	24*	...	...	4*	...	...	28*	...	5
Christchurch	...	11	...	...	...	5*, 6	23*	...	...	...	3	...	5
Hokitika .	...	11	...	...	...	24	...	...	...	...	...	...	2
Dunedin.	...	...	...	...	...	24*	...	...	...	...	...	...	1
Southland .	14*	10	...	...	...	24*	...	...	...	11*	...	25*	5

The figures denote the days of the month on which one or more shocks were felt. Those with an asterisk affixed were described as *smart* shocks. The remainder were very slight. The only earthquake which did serious injury, occurred at Christchurch on the 5th June.

NOTES ON THE WEATHER DURING 1869.

January.—Several heavy gales and thunderstorms were experienced generally throughout the colony during this month, especially in the North Island. At Taranaki, the lightning caused considerable damage on the 14th; and on the 31st, half an inch of rain fell in a quarter of an hour. Rainfall, on the whole, was lower than usual. At Dunedin, 950 miles of wind passed the station on the 3rd.

February.—Several storms of great violence occurred at most of the stations in the North Island during this month, particularly at Auckland; and the rainfall in every case was considerably greater than the average for previous years. The rainfall in Auckland on the 11th—6·329 inches,—and the force of the wind on the 27th—1,229 miles,—greatly exceed any previous daily records in that province. The weather in the South was, on the whole, fine, with slight rain.

March.—Weather remarkably fine and pleasant at all the stations in the North Island; rainfall considerably below the average for previous years. On the west coast of South Island, and south of Christchurch, the weather was not so fine; several severe storms from S.W. and N.W. occurred, accompanied with hail, thunder, and heavy rain. On the 25th, 989 miles of wind were registered at Auckland; and on the 27th, 860 miles at Wellington.

April.—Weather tolerably fine throughout the North Island, except at Taranaki and Wellington, where the rainfall was excessive. In the South Island wet weather prevailed. In Southland the month was characterized by a dull, cloudy, and very moist atmosphere, with light drizzling rain on twenty days. At the mountain station at Bealey, snow fell on the 15th, 16th, and 27th.

May.—Strong W. and S.W. winds prevailed at almost all the stations from the 3rd to about the 7th days, accompanied in many cases with rain, thunder, and hail; the weather was especially severe at Southland, where there was also a heavy snow storm on the 7th. Rainfall at all the stations unusually heavy. In Auckland, 889 miles of wind on the 23rd.

June.—Weather on the whole fine, but with several severe storms; average force of wind low; and total rainfall for the colony rather lower than same period in previous years. In Auckland, on the 28th, very severe gale, described as a perfect hurricane, from N. and N.E.; much damage done in harbour; 1,170 miles of wind passed by in twenty-four hours. At Wellington, ·500 inch of rain fell in about fifteen minutes, on the 30th.

July.—The weather throughout the colony for this month was much finer than is usually the case at this season of the year, but particularly so in the South Island. The rainfall was in almost every case far below the average, and, with the exception of a few stormy days in the North, the winds were moderate. Snow fell in Christchurch on the 8th and 24th; and in Wellington, sleet fell on the 8th. At Bealey (altitude above sea level, 2,104 feet) there were five days of snow; and on one night the minimum temperature on grass fell to 2·5°.

August.—Universally fine steady weather during this month on the East and South of the colony. On the West Coast, and in the North, stormy, with prevailing westerly winds. The average rainfall for the whole colony was that usual for the month; but the distribution was very unequal, being excessive on the West Coast.

September.—Prevalent westerly winds. The only marked change, which appears to have been generally felt, was from fine to broken weather on the 21st (full moon); the fine weather having commenced at almost every station with new moon on the 7th.

October.—Month characterized by a heavy gale from S.E. of unusual severity and persistence, accompanied by electrical disturbances, low temperature, and heavy rainfall, especially in the Wellington district. At the latter station 3·200 inches of rain fell on the 29th, in twenty-four hours. The alternation of climate was very great, without any very extreme fluctuation in the atmospheric pressure.

November.—The weather for this month was unusually fine and pleasant throughout New Zealand, the rainfall being considerably below the average, and the winds generally moderate, except on the West Coast of Middle Island, where strong S.W. winds prevailed.

December.—The most remarkable feature in the weather for this month was the occurrence of severe electrical storms, throughout almost the whole of the colony, towards the middle of the month, with vivid and dangerous lightning. There was also heavy rain at many of the stations at the same period, but no severe gales were reported.

James Hector,
Inspector of Meteorological Stations.

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1869.

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